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ITE CLASSIFICATION OF THE SOILS OF ROSTOV REGION

YA. GAVRILYUK, Rostov-on-Don State University

In connection with the problem of division in- soil districts, soil science had had to face other, no less important problem in applied ience, that of the qualitative evaluation or te classification of soils. Until recently this oblem was not treated in the USSR. The solu- n of theoretical and practical problems in the alitative evaluation (site classification) of ils is an immediate task of soil scientists and is was noted in the resolutions of the First elegates' Conference of Soil Scientists. This ticle is intended to throw light on experience the site index of soils in Rostov Region.

The soil is one of the basic sources of wealth the kolkhozes and sovkhozes, and the particu- r quality of the soil is important to the solu- n of production problems on the kolkhozes d sovkhozes. It should not be forgotten that .. labor is not the only source of the values oduced by it, of material wealth. Labor is e father of wealth, as William Petty said, d the earth is its mother. "1

We have previously noted (2) that, if the ality of soils is taken into strict account in sessing the productive activity of kolkhozes d sovkhozes, then the soil (the land) and its rtility will become a powerful factor in rais- g the productivity of labor in agriculture. ven within the same region, kolkhozes and vkhozes are located on lands that differ dely in natural fertility. Yet the results of oductive work are evaluated on the basis of e same principles and norms, without allow- ce for the quality of the soils. This is not ght. We cannot mechanically compare figures r different kolkhozes and sovkhozes as to eld per 100 hectares of arable land without king account of its quality. N. S. Khrushchev ew attention to this in 1958, in a talk with lkhoz members and agricultural specialists the Krasnodar Subdistrict. Where there are tter soil-climatic and economic conditions, there should be higher yields per 100 hectares of arable land.

It is perfectly clear that it is much easier to obtain constant abundant crops on naturally more fertile soils than on soils of inferior quality. There is a saying "there is no bad land, there are just bad masters." We still unfortunately, have both. Therefore, good farmers who obtain high yields from soils with a low natural fertility by proper cultivation should be encouraged, and careless farmers, who obtain poor crops from soils of good natural fertility because of their neglect, must be made to produce consistently abundant crops. In naturally more fertile lands, there must be higher yield per 100 ha of arable land.

This whole complex of problems raised by the very existence of the kolkhozes calls for a qualitative evaluation of soils and classified land, i. e., their site classification.

A qualitative evaluation of the soils and classified land in regions, districts, kolkhozes, and sovkhozes should initially determine approximately the degree by which the soils of one of them are better, or worse, than those of another.

In the site index of soils "particular attention is paid to the determination of the agronomical characteristics of the soil, taking into account that the site index of soils is a more accurate characterization, from the point of view of agricultural production, of the soils through comparative quantitative indexes" (7).

Naturally enough the methods of soil site index worked out by V. V. Dokuchayev and N. M. Sibertsev are not adequate now, but as Yarilov (8) quite correctly noted: "Here too, in the field of the soil site indices, the path shown by Dokuchayev will not soon be abandoned; it suggests many possibilities and perspectives which await investigation."

The fundamental principle of site index is,

K. Marx. Kapital. Vol. 1, p. 50, 1950.

of course, the classification of soils according to genesis and productivity. Thus the natural qualities of the soils and also yields for the principal grain crops were made the basis for the site index of the soils of Rostov Region and consequently also for the preliminary working scale to be used in determination of soil site quality. V. R. Vilyams (1) pointed out that "Labor productivity in agriculture is determined in the end by crop yields and crop yields by the degree of soil fertility." Only on the basis of this dual control (soil properties and yields) should the average site index be established. In evaluating soils, we must, according to Sibirtsev (6), "determine precisely the properties inherent in the soil itself and derive its site index from these."

Agreeing with Dokuchayev (5) that "the thickness and particularly the humus content in soils are an expression of the general complex of all soil-forming agents, including subsoils," for our site-quality scale of the chernozem and chestnut soil groups, we selected as genetic indexes primarily the thickness of the humus horizons is one of the basic indicators in the agricultural evaluation of soils, since, of course, the thicker the soil, the more room there is in it for the root system of the plant and the larger is the supply of nutrients. The importance of the humus content is known to all. Humus is the most essential component of th soil, determining many of its properties and its fertility. The relation between yields an soils is shown in Figure 1. We also established (3) a similar relationship between the yield of grain crops on test plots and the var ous chernozems of the northwestern Caucasu Similar relationships are also shown by data on crop yields in the kolkhozes and sovkhoze (Table 1). In preparing a preliminary worki site-quality scale for the soils (Table 2), we adopted a 100 (i.e., the standard) the characteristics of an ordinary chernozem in whic the thickness of the humus horizon A + B = 7 cm and the humus content is 425 metric tons and for which the yield is close to the mean yield of grain crops for the whole of the USS 21 cntr/ha for test plots.

An "open" quality scale of 100 points is v convenient, where the index 100 is assigned a soil of average quality, numbers above 10 to better soils and numbers under 100 to soi below average in quality.

Below, in Table 2, we present the workin site-index scale for determining of the site-quality of soils of the chernozem and chestnu groups.

Using this scale, it is possible to establis

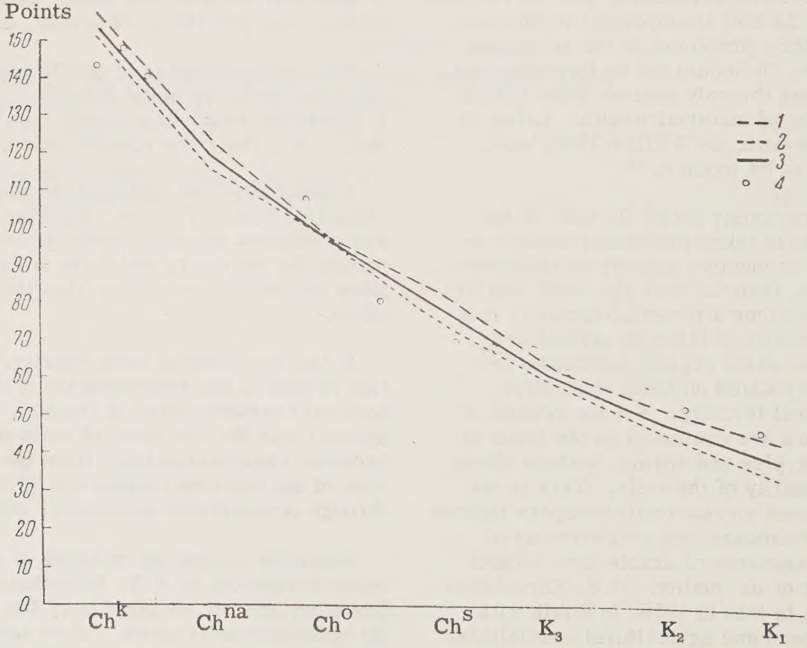

Fig. 1. - Relationship between productivity and soils in Rostov Region.

1 - soil thickness; 2 - humus content; 3 - average of the preceding; 4 - productivity. Ch^k - chernozems of the Ciscaucasus; Ch^{na} - chernozems of northern Azov region; Ch^o - ordinary chernozems; Ch^s - southern chernozems; K_3 - dark chestnut soils; K_2 - chestnut soils; K_1 - light chestnut soils.

Table 1

Grain yields for test plots on kolkhozes and sovkhozes for the various soils of Rostov Region

Soil	Yields, cntr/ha	
	Test plots	Sovkhozes and kolkhozes
Chernozems of the Ciscaucasus	29.9	14.9
Chernozems of northern Azov region	28.5	13.4
Ordinary chernozems	21.3	11.9
Southern chernozems	17.0	9.8
Dark chestnut	14.0	8.4
Chestnut	12.6	7.2
Light chestnut	10.0	3.8
Average	19.0	9.9

Table 2

Working evaluation scale for determining of the site quality of the soils of Rostov Region

Soil	A + B cm	Points	Humus, metric tons/ha	Points	Yield, cntr/ha	Points
Chernozems of the Ciscaucasus	—	—	—	—	34	162
	—	—	—	—	33	157
	>125	173	700	165	32	152
	125	166	675	159	31	148
	120	160	650	153	30	143
	115	153	625	147	29	138
	110	146	600	141	28	133
	105	140	575	135	27	129
	100	133	550	130	26	124
	95	127	525	124	25	119
Chernozems of northern Azov region	90	120	500	118	24	114
	85	113	475	112	23	110
	80	107	450	106	22	105
Ordinary chernozems	75	100	425	100	21	100
	70	93	400	94	20	95
Southern chernozems	65	86	375	88	19	90
	60	80	350	82	18	86
	55	73	325	77	17	81
Dark chestnut	50	66	300	71	16	76
	45	60	275	65	15	71
Chestnut	40	53	250	59	14	67
	35	46	225	53	13	62
Light chestnut	30	40	200	47	12	57
	<25	33	175	41	11	52
	—	—	150	35	10	48
	—	—	125	29	9	43

preliminary site index for the principal soils f the region, a district, or a kolkhoz. For his, we must know the names of the soils, he thickness of the humus horizons, the humus ontent, and the yields. Let us say, for instance, that we are interested in the site quality of the Ciscaucasian calcareous chernozem in Tselinsk District of Rostov Region, where A + B = 110 cm, the humus content is 625 metric tons/ha, and the yields for basic grain crops of a test plot located on a similar soil is 30 cntr/ha. With these data (Table 2), we find that the site index for the Ciscaucasian chernozem concerned is equal to 146.5 ([146 + 147] ÷ 2) according to soil characteristics, and 143 according to yield. Hence the average (for natural properties and yield) is (146.5 + 143) ÷ 2 = 144.7. The figure of 144.7 points is then the average site index of the Ciscaucasian calcareous chernozem.

If, for instance, we are interested in the site quality of the southern chernozem in Tarasovo District of Rostov Region, where A + B = 65 cm, the humus content is 375 metric tons/ha, and the yield on the Tarasovo test plot is 17 cntr/ha. We shall first define the mean quality index (Table 2), which according to the natural soil characteristics will in this case be (85 + 88) ÷ 2 = 87. We further find that with a yield of 17 cntr/ha the site index for the soil is 81. The mean site index for the southern chernozem will be (87 + 81) ÷ 2 = 84.

In this way we can also determine the quality of the other soils indicated in Table 2; that is, of all basic subgroups of chernozem and chestnut soils in Rostov Region.

To define more precisely the quality of soils, as to texture and erosion, we made use of the corresponding correction coefficients of S. S. Sobolev and M. N. Malyshkin (7).

Knowing the site quality of the soils and the area occupied by them, we determined the site quality of the classified lands. For instance, the area of cultivated land in district "A" is represented by the following soils: Ciscaucasian chernozems, 65%; southern chernozems, 25%; and chestnut, 10%. In district "B", Ciscaucasian chernozems, 4%; southern chernozems, 11%; and chestnut, 85%.

Average site quality of cultivated
land in district "A"

Ch^k — 65 x 145 = 9,425

Ch^s — 25 x 84 = 2,100

K_2 — 10 x 55 = 550

Total 100% — 12,075 points

Dividing the sum of the site indexes by 100, we obtain the site index for the arable land of district "A", which in this case will equal 121.

Average site quality of classified land
in district "B"

Ch^k — 4 x 145 = 580

Ch^s — 11 x 84 = 924

K_2 — 85 x 55 = 4,675

Total of values — 6,179 points

Dividing the sum of the site indexes of the soils by the area they occupy, in this case take as 100%, we obtain for district "B" an average site index of 61.79.

It follows then that the land in district "A", with a site index of 121, is almost twice as goo as in district "B", where the index is only 62.

In this way it is possible to determine the quality of the classified land not only of distric and kolkhozes, but also of brigade tracts.

For a visual picture of the quality of the classified land of districts, kolkhozes, and sovkhozes, we must also have, in addition to soil maps, cartograms of the soil site quality for the classified land.

In this article only the basic outlines of a possible approach to the qualitative evaluation (site-classification) of soils and classified lands are given. Many very complex aspects of this problem of vital importance to agriculture still await their further study and solution

The problem of soil site classification is no less complex than the problem of soil classific tion or the problem of division into soil districts. It is therefore essential, first of all, to adopt basic principles for soil site index, as we do in soil classification or districting. Fur ther, on the basis of the site-index principles adopted, it is necessary to establish the basic site quality of the zonal soils of the USSR, its subdistricts and regions, i. e., "the reference site indexes for the soils," which will serve as a basis for a more extensive site index, jus as soil groups serve as the basis for the gener and regional classification of soils.

From a knowledge of the site quality of the zonal soils of the USSR, it is possible to work out in greater detail site-quality scales for a subdistrict and a region in conformity with the local soil and climatic conditions. Just as all soil groups encountered over the vast expanse of the USSR cannot be encompassed in one classification, so it is also practically im possible to compile a single site-quality scale to encompass the diversity of the soils of the USSR.

At this stage in the qualitative evaluation (sit index) of the soils of the USSR, it is desirable to work out, as soon as possible: 1) general princi ples and methods of soil site index and 2) "refer ence site indexes" for the zonal soils of the USSR This makes it possible to solve the problem s indexing of the soils of the USSR considerably faster under a single plow.

In Table 3 a preliminary site-quality scal is given for the basic soils of Rostov Region.

At the present time, on the basis of the available soil-map data and yields, it is essential to compile and to define more exactly

Table 3

A preliminary site-quality (evaluation) scale of the soils of the Rostov Oblast'

Index	Soil	Site index points
Ch_1''''	Typical chernozems, low in humus, very thick (leached Ciscaucasus chernozems)	151—160
$Ch_1^{k''''}$	Carbonate chernozems, low in humus, very thick (carbonate Ciscaucasus chernozems)	141—150
Ch_1''	Typical chernozems, low in humus, thick (leached Azov region chernozems)	131—140
$Ch_1^{k''}$	Carbonate chernozems, low in humus, thick (Carbonate Azov-region chernozems)	121—130
Ch_2''	Ordinary chernozems, medium humus content, medium thickness, on loess-like parent materials	111—120
Ch_2''	The same, on clay	101—110
Ch^s	Southern chernozems on loess-like parent materials	91—100
Ch^s	The same on clay	81— 90
K_3	Dark chestnut soils, on loess-like parent materials	71— 80
K_3	The same on clay	61— 70
K_2	Chestnut	51— 60
K_1	Light chestnut	41— 50
S_n	Deep columnar solonetzes of the chernozem zone	31— 40
S_n	The same, medium columnar, chestnut zone	21— 30
S_n	The same, crusty, of the chernozem zone	11— 20
S_n	The same, crusty, of the chernozem zone	1— 10
S_ki	Solonchaks, hilly sands	0— 1

Note: The soil names are in accordance with the legend on the State Soil Map of the USSR. Local soil names (4) are given in parentheses.

e., to refine in accordance with local soil and imatic conditions, site-quality scales for the onal soils of the USSR, as worked out by the V. Dokuchayev Soil Institute of the Academy Sciences, USSR; to improve the correction oefficients for the degree of erosion, texture, nd other characteristics which reflect soil roperties.

The present site-quality scale should be condered as a first attempt, to be improved as ethods improve and more data accumulates on e soils of Rostov Region.

The problem of soil quality is quite complited, and soil scientists, agronomists, and ricultural economists must take part in its lution together with those that practice agrilture — the kolkhoz workers. Only a thorough evelopment adoption of the methods of qualitave soil evaluation based on concrete local data ill achieve its aim, i. e, it will promote a more tional management of agriculture.

The methods and the working evaluation bles of soils should be devised, above all, the basis of objective soil properties and, course, on the proved yields for the leading ain crops in the region or district as verified er many years. The working tables must be mple, as only then will they find wide use in the qualitative evaluation of the soils of kolkhozes and sovkhozes.

The problem of soil evaluation is of an immense scientific and practical importance and it is an urgent task facing the soil scientists of the USSR.

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ERTICAL SOIL ZONALITY IN NORTH VIETNAM[1]

M. FRIDLAND, V. V. Dokuchayev Soil Institute, Academy of Sciences, USSR

North Vietnam lies in the northeastern part he Indochina peninsula, between 23°N and N, i. e., entirely within the tropics.

The topography of North Vietnam divides arly into three different levels: a) very ng delta and coastal alluvial plains, with vations up to 25 m, totally featureless; b) egion of hilly relief, marked by severe dis- tion into an unending alternation of rounded locks and dales; c) a mountain region, very erogenous, as determined by the geological tory and lithology of its various parts. Ele- ions here range between 150 and 3,142 m n Si Pan Mountain, highest point in North tnam). Mountains cover nearly three- rters of the country's total area, and there- e vertical zonality is the basic principle erning the geography of soils in North Viet- n.

The climate of North Vietnam is marked by seasons: a rainy and moist summer, and inter with far less precipitation, but still h a considerable atmospheric humidity; se seasons result from the alternation of summer and winter monsoons.

In the southern parts of North Vietnam (Table Dong Hoi station) the rainy season shifts to- rds fall and early winter; little precipitation urs in summer.

According to the data of Hanoi station, in northern region of the country (delta of Bac Bo), monthly average temperatures ctuate throughout the year from 28.9° to 5°C. At Dong Hoi station, on the coastal lands in the south of North Vietnam, somewhat higher temperatures are recorded (monthly averages of 30.0-18.6°C). Temperatures decrease markedly with elevation; thus, at Cha Pa station (1,640 m), monthly averages fluctuate between 20.4°C and 8.0°C. Comparing the Hanoi and Cha Pa data, we note a decrease of 0.4-0.5°C per 100 m.

Throughout North Vietnam annual precipitation exceeds annual evaporation by a factor of two or more. An analysis of monthly averages of precipitation and evaporation defines clearly two seasons; one is marked by a predominance of precipitation over evaporation, the other by the reverse.

The duration of these seasons differs in various parts of the country. In Hanoi the dry season is 4-1/2 months long, while the wet season lasts 7-1/2 months. In Dong Hoi they last 5-1/2 and 6-1/2 months, respectively. High areas in the mountains (Cha Pa), there is essentially no dry season.

Comparison of the differences between total precipitation and evaporation in the dry and wet months shows that in the wet months precipitation exceeds evaporation by far more than the evaporation exceeds precipitation in the dry months. Also, the ability of the soil to accumulate moisture during the moist months for use by plants during the dry season reduces the aridity of the dry season. Therefore, the soil and lower atmospheric climates are wetter than the macroclimate and the duration as well as the intensity of the dry season in the lower atmospheric layers (especially in forests), is much less pronounced than the meteorological data seem to indicate.

Comparison of data for mountains and lowlands clearly indicates that in the mountains, while seasonal alternation remains, the temperature decreases and the dry season shortens with increasing altitude, and that in very high places the dry season disappears completely. These phenomena are the principal causes of vertical zonality.

This article is based on field investigations in 7-1958, organized by the research institute of t cultivation of the Ministry of Agriculture and estry of the People's Republic of Vietnam. The owing took part in these field investigations: Vu c Tuyen, Ton That Tieu, Do An, Tran Van Nam, yen Van Zung and Le Van Ba.

Table 1

Climate characteristics of certain points in Northern Vietnam[a]

Months	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Hanoi 20°59'N, 105°51'E, elevation 7 m													
Mean temp., °C	15.5	17.0	19.7	28.6	27.4	28.9	28.4	28.4	27.1	24.4	24.4	18.4	23.4
Mean relative humidity, %	82	84	86	87	84	83	83	84	85	82	81	81	84
Precipitation, mm	22	24	45	89	216	254	315	334	276	114	48	27	1891
Evaporation, mm	58	45	48	53	73	87	76	73	69	77	73	60	787
Dong Hoi 17°29'N, 106°16'E, elevation 7 m													
Mean temp., °C	18.6	19.9	21.1	24.7	27.9	30.0	29.3	29.3	27.6	25.1	22.6	20.9	24.8
Mean relative humidity, %	90	90	90	87	81	73	74	75	86	86	88	88	84
Precipitation, mm	62	37	43	48	99	74	107	118	439	509	340	137	2015
Evaporation, mm	35	37	39	57	96	145	137	131	70	63	50	46	906
Cha Pa 22°24'N, 103°32'E, elevation 1640 m													
Mean temp., °C	8.0	9.9	13.1	16.0	19.1	19.4	20.4	19.8	18.3	15.4	12.8	11.1	15.7
Mean relative humidity, %	74	72	84	76	85	92	89	92	91	90	90	90	85
Precipitation, mm	43	79	110	183	390	341	473	470	341	180	117	43	2770
Evaporation, mm	50	61	43	73	55	30	43	28	32	28	27	23	493

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[a] According to Bruzon and others (5).

More than forty years ago Chevalier (6) pub-
hed a description of the forests of French
lochina, including North Vietnam, which was
that time a part of this French colony. Che-
lier distinguishes three vertical forest zones:
below 700 m, where tropical forests pre-
minate; 2) between 700-1,500 m, where
ny plants typical of cooler conditions occur
ngside tropical plants; and 3) above 1,500
where tropical plants are even less abun-
nt.

Later works (8, 9) confirmed Chevalier's
ggestion, but moved the boundary between the
ddle and upper zones to 1,800-2,000 m.

The evergreen, broadleaf tropical forests of
lower zone (plains, hills and low mountains),
garded by many authors as equatorial forests,
ve now been either destroyed or replaced by
condary forests. In the primary stage these
rests are characterized by a variegated as-
rtment of large trees. Important among
em are representatives of the following
milies: legumes (including the well-known
nwood), *Dipterocarpi*, *Sterculiaceae*, and
ny others.

These trees are 40 m high, and higher; their
owns merge and cause total shadow although
trunks stand as much as 10 m apart. The
rest is passable despite thick lianes and
iphytes. There is no living ground cover;
forest litter, consisting of leaves, small
anches and fruits, reaches 1 cm in thickness.
wever, primary forests are scarce in this
ne. Secondary forests marked by lower and
nser plant growth and tightly interwoven with
nes predominate. Despite the difference in
eir composition, these forests have the same
ound cover as primary forests.

The evergreens predominate in the middle
ne (700-1,800 m), but deciduous forms also
pear. The most common are numerous rep-
sentatives of the laurel and the magnolia
milies. Typical tropical plants gradually
sappear towards the upper parts of the zone,
ere evergreen oak predominates. In the
ddle zone the trees are 20-25 m high, less
l than in the lower zone. This zone is
rked by a wide distribution of tree-like
ns and thickets of wild bananas in the wet
rrow valleys. In the underbrush varieties of
mboo abound, forming thickets stretching for
ny kilometers. The presence of thick litter,
m deep and more, is characteristic of the
rests of this zone.

The forests of the upper zone appear above
00 m. They are very humid with permanent
sts and are consequently called "mist forests."
nifers appear here together with evergreen
ks and other leaf-bearing trees. The trees
not higher than 12-15 m, with distorted
nks and branches, covered with mosses and lichens which sometimes form a continuous cover. Bamboos, rhododendrons, and various ferns predominate in the lower stories of these mist forests. Green mosses form the ground cover. Vertical soil zones are related to the vertical plant zones under consideration.

Before describing the mountain soils of North Vietnam, a short description must be given of the soils of the hill country, characteristic of that horizontal zone from which the entire series of vertical soil zones begins. A comparison should be drawn between these hill country soils and the soils of the vertical zones (since alluvial and related soils are developed on the plains). An example of this is given in a cut of lateritic soil developed on granite.

Profile 122. Province Quang Bin, Bo Trak region, Fukun state farm. Top of gently sloping hill covered with an evergreen broadleaf secondary forest. The trees are 12-15 m high. Forest litter consists only of dry leaves, and is practically absent.

A, 0-10 cm. Grayish brick-red, sandy medium clay loam, unstable blocky, fresh; quartz and mica grains. Gradual transition.

AC, 10-35 cm. Reddish dark-brown, sandy fine clay loam, unstable blocky, fresh, quartz and mica grains. Gradual transition.

C_1, 35-90 cm. Reddish-brown, sandy fine clay loam, structureless, rather wet, quartz and mica grains. Marked transition.

C_2, 90-110 cm. Similar to the preceding, but with larger quartz grains; it was impossible to dig deeper due to the presence of a quartz vein.

The particle-size analysis (Table 2) clearly indicates a predominance of the fractions >0.1 and <0.001 mm in diameter. The fraction >0.1 mm in diameter consists almost entirely of quartz, a mineral highly resistant to weathering; the <0.001 mm diameter fraction consists of weathering products. A low content of intermediate fractions indicates advanced weathering and a low content of potential (4) minerals (primary minerals capable of further weathering). The coarser particle sizes of the upper horizons, as compared with the lower ones, suggests an illimerization process (3), but this can be established finally only after total chemical and mineralogical analyses.

The very small loss after treatment with HCl (Table 2) shows a negligible content of soluble substances in the soil.

Analyses (Table 3) show an acid reaction of soil and consequently a low basic content. The humus content is low and the C:N ratio suggests a high degree of decomposition of the organic substances. In this soil (as in all the

Table 2

Particle-size analysis of lateritic soil, %[a]. Profile 122

Depth, cm	Hygroscopic moisture, %	Loss after treatment with HCl, %	Particle content >1 mm in dia.	Particle diameter, mm						
				1.0—0.25	0.25—0.1	0.1—0.05	0.05—0.01	0.01—0.005	0.005—0.001	<0.001
0—10	1.5	1.4	11	17	38	8	9	1	10	17
10—30	1.6	2.3	13	13	38	9	6	2	13	19
40—60	1.5	1.1	21	15	34	8	7	1	7	28
60—80	1.7	0.9	25	13	32	7	6	4	7	31
80—100	1.9	0.0	32	14	29	4	6	2	9	36
100—110	2.4	0.9	Not det'd.	17	24	5	9	1	9	35

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[a] The analyses were performed in the laboratories of the research institute of plant cultivation by the chemists: Pham Tham, Nguyen Din Thoai, Chin Van Nong, Do Suan Ha, Chan Ngoc Thyu, Nguyen Chung, Dang Thia Chang, and Ngo Van Luyen. The particle-size analysis was determined by Kachinskiy's method: pH — colorimetrically by Alyamovskiy's method; humus — according to Tyurin; nitrogen — according to K'yel'dal'; exchangeable Ca and Mg by the trilonometric method, and exchangeable hydrogen according to Gedroyts (i. e., determination of the total exchangeable hydrogen and aluminum).

Table 3

Analysis of lateritic soils. Profile 122

Depth, cm	Hygroscopic moisture %	pH of KCl suspension[a]	Humus	Nitrogen	C : N	Exchange cations meq/100 g soil				Degree of saturation %	Total exchange cations in meq comp. per 100 g of fraction <0.001 mm in diam.
			In %			Ca	Mg	H + Al	Total		
0—10	1.5	4.1	2.29	0.108	12.3	0.3	0.2	2.8	3.3	15	21
10—30	1.6	4.1	1.41	0.057	14.5	0.2	0.1	1.4	1.7	15	9
40—60	1.5	4.1	1.00	0.054	10.8	0.2	0.1	1.8	2.1	13	8
60—80	1.7	4.1	Not det'd.		—	0.2	0.3	2.8	3.3	16	11
80—100	1.9	4.1			—	0.4	0.2	3.7	4.3	14	13
100—110	2.4	4.3	"	"	—	0.5	0.4	2.4	3.3	27	10

[a] Not determined.

Table 4

Analysis of mountain lateritic soil. Profile 241

Depth, cm	Hygroscopic water, %	pH of KCl suspension	Humus	Nitrog.	C : N	Exchange cations in meq 1 per 100 g of soil				Degree of saturation %
			In %			Ca	Mg	H + Al	Total	
1—5	6.0	4.0	5.36	0.267	11.6	Not det'd.			—	—
7—13	5.4	4.2	5.01	0.147	19.5	0.7	0.6	8.1	9.4	12
15—20	5.3	4.2	2.85	0.118	13.9	Not det'd.			—	—
22—32	5.8	4.0	2,33	0.104	14.0	"	"		—	—
40—50	5.5	4.4	Not det'd.		—	0.4	0.4	9.6	10.4	8
120—130	4.4	4.3	"	"	—	0.4	0.2	7.1	7.7	8

rofiles already described) the C:N ratio is ighest in the middle part of the humus horizon, hich indicates a migration of organic matter in ie soil profile.

The very low content of exchangeable cations s worth noting. On conversion to 100 g of clay has a characteristic value for kaolinite in all orizons (except the uppermost, perhaps as a reult of higher humus content).

Though the lateritic soils described in Prole 122 are typical, there are some in which ie illimerization is not expressed, and others hich contain many concretions, usually feruginous, and sometimes a compact laterite orizon. These soils vary also according to ie use to which they are put, their parent maerial, and vegetation.

Mountain lateritic soils, including those in ie lower forest zone (below 700 m) but on a iountainous relief, differ from lateritic soils i that they are formed on a thinner weathered ayer, the humus content is higher, and no conretions or dense laterite horizons are enountered.

The following profile is an example of iountain lateritic soil (probably illimerized).

Profile 241. Province of Cao Bang, Tac An egion, 1.5 km east of the village of Ban Ba. Ipper part of an elevated watershed (elevation: 60 m), slope 6-8°, eastern exposure. Everreen secondary tropical forest, numerous iquidambars, evergreen oaks, Japan yews, nd others.

A_0, 0-1 cm. Litter of dry leaves.

A_1, 1-6 cm. Dark gray, friable, finerained, fresh, clay loam, densely penetrated ith small roots. Marked transition.

A_1', 6-14 cm. Brownish-gray, large locky, porous non-stable, much more comact, rather moist, less roots, clay loam. Disnct transition.

$A_1 A_2$, 14-21 cm. Brownish gray, not omogenous as to color; blocky, moist, somehat plastic, clay loam, units can easily be rushed. Transition marked by color.

A_2 B, 21-34 cm. Bright brown, with a gray nge on the surface of structural units, large locky, rather moist, plastic, fine clay loam, uartzitic grains, small fragments of decaying ocks. Transition marked both by color and ompaction.

B, 34-80 cm. Reddish brown, large blocky, ompact, rather moist, plastic, fine clay loam, ccasional manganous-ferruginous concretions, ccasional roots. Transition gradual, according to color.

BC, 80-100 cm. Reddish light brown with darker and lighter spots, rather moist, plastic, occasional roots.

CD, 100-110 cm. Light brown clay loam, occasional quartz grains.

D, 110-130 cm. Large yellowish-white pockets of weathered rhyolite with reddish brown fine clay loam material.

Analyses of soils in this profile are given in Table 4.

The mountain lateritic soils differ from other lateritic soils by their higher humus content and a lower degree of decomposition of organic matter. Its degree of saturation is markedly lower whereas the amount of exchangeable cations is higher. The higher exchange capacity can be explained by a finer texture inferred from the amount of hygroscopic moisture.

In the middle zone (from 700-800 to 1700-1800 m) soils with a deeply humified, markedly coarse humus A_0A_1 horizon, predominate.

These soils are typically yellowish, red tints being rarer than in the lower zone. The following profile is an example of these soils.

Profile 23. Province Nge An, Cua Rau region, mountain, massif Phu Kuok Phon Sen. Altitude: 870 m; the exposure is ENE, with 8°10° slope. The forest stands 10-15 m high, the profile is situated in a partly cut-over area. Bamboo abundant, fern also found. Very few herbaceous plants, woody vegetation predominant. Much rotting felled timber. The ground is not completely covered with leaves.

A_0A_1, 0-4 cm. Cinnamon brownish gray friable layer, penetrated with many roots, fine-grained, rather moist (grains therefore loose), clay loam. Clear transition.

A_1, 4-15 cm. Grayish-cinnamon brown, friable, blocky to granular, clay loam, rather moist, structural units easily broken, many roots (sod formation from the roots). Gradual transition.

AB, 15-32 cm. Clay loam, brown with a gray tinge, friable, rather moist, many roots, granular to blocky. Gradual transition.

BC, 32-54 cm. Brownish yellow, more compact, blocky, rather moist, grassy, fewer roots, occasional fragments of weathered rocks. Gradual transition.

C, 54-85 cm. Reddish brown clay loam, fairly compact, structureless, contains many

Table 5

Particle-size analysis of soils in the middle mountain zone, %

Profile No.	Depth, cm	Hygroscopic moisture	Loss after treat. with HCl	Particle diameter, mm						
		In percent		1.0—–0.25	0.25—–0.1	0.1—–0.065	0.05—–0.01	0.01—–0.05	0.005—–0.001	< 0.001
23	0—4	4.9	1.8	5	8	34	26	7	17	3
	6—12	4.0	1.6	3	9	18	31	10	16	10
	20—30	3.8	1.2	5	12	11	31	11	15	14
	40—50	2.4	1.8	4	11	11	34	11	17	10
	60—70	1.8	1.1	5	15	38	11	9	7	14
	75—85	1.6	2.1	18	5	14	35	5	11	10
171	1—5	5.4	1.7	14	25	3	16	1	23	17
	6 - 10	4.2	2.6	12	19	12	11	5	23	15
	12—16	4.7	1.0	8	18	8	20	4	22	20
	18—22	4.1	0.9	9	17	7	14	8	24	21
	24—29	3.8	0.8	10	17	14	6	7	24	22
	31—41	3.6	1.0	7	13	10	11	10	21	23
	45—55	3.5	0.6	7	13	9	14	4	24	28
	60—80	3.2	1.5	7	13	3	18	16	21	21
	100—120	3.0	1.4	6	4	12	18	11	20	28
	120—140	3.0	0.8	8	5	12	21	10	18	26
	150—170	2.4	1.7	8	7	11	23	7	20	24
	190—210	2.4	1.5	6	6	11	27	14	16	19

fragments of weathered rocks, particularly in the lower part, rather moist, often with roots.

The particle-size analysis of soils in the middle zone is given in Table 5 (Profile 171, elevation 900 m, under a secondary forest with large trunks; parent material granite).

Middle zone laterites differ from lower zone laterites by their comparatively high silt content, owing to a less advanced weathering and the presence of potential minerals. The low content of clay-particles in the upper profile indicates that these have been removed.

Analyses of soil profiles in the middle mountain zone (Table 6) showed a high humus content in the upper horizon, which rapidly decreases with depth. The high C:N ratio indicates slight decomposition of the organic matter. The amount of exchangeable calcium and magnesium is very small, and that of exchangeable (and also aluminum) is fairly high; this causes only slight saturation, entirely conformable with a high acid reaction. The loss after treatment with HCl (Table 5) is small, proving a strong leaching of the soil; the loss is, however, higher than in lateritic soils. This in accordance with the higher content of primary minerals and various intermediate products of weathering; this explains also the high exchange capacity of the clay, which even in humus free horizons reaches 30 meq/100 g of clay. This figure may be related to several minerals tetrahydrated halloysite, illite, chlorite, palygorskite, and others, but they all show less weathering than kaolinite.

Horizons with a considerable humus content have a very high exchange capacity, in contrast with lateritic soil in which an increas in humus content does not increase the exchange capacity. Either the humus here diffe from that in lateritic soils, or it is not strongly bound to sesquioxides, mostly ferric, whic decrease the exchange capacity in lateritic soils.

The following profile is an example of characteristic properties of soils of the zone of mi forests, situated above 1800-1900 m.

Profile 356. National district of Thai Meo, Phang Tho region, near the mountain pass between the villages of Cha Pa and Bin Ly. Elevation 1950 m. Plateau-like surface with low (30-50 m) and rather steep hills. The profile is on the top of one of the hills underlain by gneiss. The "mist forest" consists of evergreen trees with big bamboo and of evergreen shrubs similar to rhododendron; the trees an bamboo are covered with moss and lichens. T ground cover consists of fern, ginger and gra

A_0, 0-1 cm. Fresh leafy litter.

A_0A_1, 1-7 cm. Brownish black, sandy-clay, thorough penetrated with roots, moist t

Table 6

Analysis of mountain humus-lateritic soils

Profile number	Depth, cm	Hygroscopic moisture, %	pH of KCl suspension	Humus	Nitrog.	C : N	Exchange cations, meq per 100 g soil				Degree of saturation, %	Exchange cations, meq per 100 g of fraction <0.001 mm
				In %			Ca	Mg	H + Al	Total		
23	0— 4	4.9	4	13.2	0.497	15.4	0.5	0.5	14.1	15.1	7	501
	6—12	4.0	4	7.8	0.281	16.1	0.5	0.5	20.3	21.3	5	213
	20—30	3.8	4	3.2	0.101	17.8	0.5	0.6	12.8	13.9	8	99
	40 - 50	2.4	4	1.1	0.036	17.3	0.5	0.4	6.1	7.0	17	70
	60—70	1.8	4	0.9	0.040	13.3	0.4	0.4	6.4	7.2	12	51
	75—85	1.6	4	0.7	Not det'd.	—	0.5	0.3	2.2	3.0	27	30
171	1— 5	5.4	4.1	9.4	0.284	19.2	0.3	0.1	11.8	12.2	4	72
	6—10	4.2	4.1	6.7	0.223	17.4	0.3	0.1	13.0	13.4	3	90
	12—16	4.7	4.1	4.0	0.167	13.6	0.2	0.2	12.5	12.9	3	65
	18—22	4.1	4.1	2.8	0.111	14.5	0.2	0.1	9.5	9.8	3	47
	24—29	3.8	4.1	2.2	0.119	10.6	0.2	0.1	10.8	11.1	2	50
	31—41	3.6	4.1	1.9	0.129	8.6	0.1	0.1	8.7	8.9	3	32
	45—55	3.5	4.1	1.6	0.092	9.8	0.3	0.1	7.2	7.6	5	28
	60—80	3.2	4.2	Not det'd.		—	0.5	0.5	5.7	6.7	15	32
	100—120	3.0	4.2	"		—	0.2	0.1	4.1	4.4	6	15
	120—140	3.0	4.2	"		—	0.2	0.1	7.2	7.3	3	29
	150—170	2.4	4.2	"		—	0.1	0.1	7.1	7.3	3	31
	190—210	2.4	4.2	"		—	0.1	0.1	5.7	5.9	4	31

vet, unstable granular structure, pliable, riable. Marked transition.

A_1, 7-27 cm. Brownish dark-gray to black, sandy-clay, unstable blocky to granular strucure, many roots, damp to wet, friable. Clear ransition.

AC, 27-32 cm. Whitish brown with a gray inge, becoming light with depth, sandy-clay, structureless, moist; irregularly colored, vith whitish clayey pockets. Gradual transiion.

C_1, 35-55 cm. White with a yellow tinge, composed of a white clayey substance and quartz. Gradual transition.

C_2, 55-80 cm. White clayey substance with quartz, with a preserved structure of gneiss.

Analyses of this soil are given in Tables 7 and 8.

Quartz grains (>1 mm in diameter) originatng in the gneiss parent material predominate n this soil. The sandy and coarse silt fracions are also high. Medium and fine silt are ound in small quantities, which suggest an advanced stage of weathering. The high humus content in the upper-most parts, and its sharp decrease with depth, distinguish this soil from the previous groups. It has an acid reaction and a very low degree of saturation. The amount of exchangeable cations per 100 g clay is the same as the amount found in the previous soils, suggesting a similar clay composition. The similarity in organic matter content and in amount of exchangeable cations indicates that the organic fraction of the soil has a considerable exchange capacity; this suggests a similarity with the soils of the middle zone, and a dissimilarity with the lateritic and mountain lateritic soils of the hill and low mountain zone.

In conclusion, several regularities can be noted in vertical zonality of the soil properties:

1. Humus content increases with higher elevations, whereas the degree of decomposition decreases, as deduced from the morphology and C:N ratio. The humus content of the soils in the higher mountains, usually deeply humified, decreases with increasing depth much more rapidly than it does at lower elevations.

2. The change in properties of organic matter

(that is, the nature of its bond with the mineral component of the soil) with elevation is also exemplified by a greater dependence of the amount of cation exchange on the organic matter content of soils at high elevations, as compared with soils at lower elevations. This is also demonstrated in the decrease of humus coloring at higher elevations. In Profile 356, for example, the C horizon contains more than 1.5% organic matter, yet it is absolutely white.

3. With higher elevation, red shades are replaced by brown and yellow. As noted by Mohr and Van Baren (10), this is connected with the increase of soil moisture with elevation, which in turn increases hydration of iron oxides, changing red tones to brown and yellow. In particularly wet conditions (e. g., in the zone of mist forests) soils can sometimes acquire a white coloring as a result of excessive moisture throughout the year, and because of the predominantly reducing environment which leads to the leaching of iron.

Moreover, added to this regular variation of color, there are two local but nevertheless very important color patterns. The first is a result of the influence of the meso- and micr relief of the distribution of precipitation: this was noted by Gerasimov and Ma Yun-chin (1). The second is determined by the parent material: on rocks with a high iron content (e. g basalt) soils are brighter than on rocks low in iron (e. g., granite). Thus the division of tropical soil into red and yellow soils, which was stressed by Zonn and Li Chen-kwei (2), may be due to different causes, and may have different genetic and classification significanc

4. In lowland and hilly terrains, laterites often contain concretions (mainly manganese-ferruginous), or even compact laterite layers In mountain areas, lateritic horizons are completely absent and concretions are exceedingly rare.

5. At higher elevations, the degree of weathering and lateritic content of the parent material and soil decreases. This is clearly seen in field and analysis data (Tables 2-6). However, owing to the lack of total and mineralogical analyses of soils and their clay fractions, we cannot investigate this question in more detail. The maturity of weathering

Table 7

Particle-size analysis of soils in the high mountain zone, in %. Profile 356.

Depth, cm	Hygroscopic moisture, %	Loss after treatment with HCl	Particle diameter >1 mm	Particle diameter, mm						
		In percent		1— —0.25	0.25— —0.1	0.1— —0.05	0.05— —0.01	0.01— —0.005	0.005— —0.001	>0.001
1—6	8.0	2.1	36	16	8	31	17	4	11	13
12—22	7.4	3.6	30	16	10	21	19	6	13	15
28—34	7.5	2.2	36	20	15	5	25	5	16	16
40—50	4.4	1.9	48	12	17	25	19	7	7	13
70—80	4.3	1.3	43	32	18	0	25	1	15	9

Table 8

Analysis of mountain lateritic-humus soils. Profile 356.

Depth, cm	Hygroscopic moisture, %	pH of KCl suspension	Humus	Nitrog.	C : N	Exchange cations, meq per 100 g soil				Degree of saturation %	Exchange cations, meq per 100 g of <0.001 mm diameter
			In percent			Ca	Mg	H+Al	Total		
1—6	8.0	4.2	Many roots		—	1.2	0.8	9.7	11.7	18	90
12—22	7.4	4.1	11.5	0.360	18.0	0.3	0.2	6.4	7.0	8	47
28—34	7.5	4.1	5.2	0.151	20.0	0.4	0.1	5.3	5.8	9	30
40—50	4.4	4.1	1.8	0.146	7.5	0.5	0.1	4.2	4.6	9	35
70—80	4.3	4.1	0.2	0.022	9.1	0.4	0.0	3.3	3.7	15	44

epends not only on the bioclimatic conditions
etermined by vertical zonality, but also on the
ind of rocks subject to weathering, as well as
n the relief features which determine the in-
ensity of leaching. Profile 356 exemplifies this:
hough located at a high elevation, the profile and
article-size composition indicate advanced lat-
ritization. This is due to the fact that this area
s a Pliocene peneplain raised to considerable
eight by Quaternary vault uplift, as evidenced
y the geologic structure and relief of this ter-
itory. Thus the degree of laterization found
n Profile 356 resulted from a very long proc-
ss, and arose in different bioclimatic cir-
umstances, typical of much lower elevations.

6. It apparently follows that the soil's or-
anic and mineral parts change in accordance
ith elevation, but exceptions may occur when
for geomorphological and paleogeographical
easons) the mineral and organic parts of the
oil do not correspond.

Beside the example mentioned earlier, there
re large areas in the lateritic zone (hill and
ow mountain) which because of intensive ero-
ion are covered by only slightly laterized
oils.

The pattern of changes in soil properties
n tropical mountains, as previously outlined,
vas also observed by us in Southern China.
Iere, of course, the pattern is greatly in-
luenced by local conditions. In the dry Kun-
ning plateau (about 2000 m), "mist forests"
nd corresponding soils do not develop as
hey do in North Vietnam; but the general pat-
ern of soil properties is preserved.

When determining the taxonomic position of
oils in North Vietnam, one might assume that
ince in tropical mountains, above the zone of
ateritic soils, temperatures prevail which
re typical for subtropical conditions, krasno-
ems and zheltozems must develop. This is
ot so. Except for a few similarities, humid
ropic mountain soils differ substantially from
ubtropical krasnozems and zheltozems, espe-
ially in character and content of organic sub-
tances.

Mohr and Von Baren (10), when describing
umid tropic mountain soils, found similari-
ies between them and podzolic soils. Dames
7) described mountain humus soils in Central
'ava (above 1000 m) which resemble the soils
ve have been discussing. He attributed their
levelopment to the parent material (volcanic
shes of high moisture capacity), and because
e found them on the coastal plain, he prefer-
ed to call them brown humus soils.

To classify these soils more precisely will
ntail further study of their mineral and or-
anic components, as well as of the processes
ccurring within them, and of their relationship with the environment.

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MEADOW-CHENOZEM SOILS OF NORTHERN KAZAKHSTAN

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Meadow-chernozem soils are widespread in the chernozem zone of Western Siberia and Northern Kazakhstan. They are particularly frequent in the forest-steppe zone of the Western Siberian lowland. They also occur in low-lying districts of the Kokchetav upland.

Such soils have been described by Gorshenin (2, 3), and quite recently by Afanas'yeva and Bakhtin (1), Kulakov (10), Panov (13), Nepryakhin (11), and the present author (5, 6). However, the problems of their genesis, classification and points of difference from chernozems still remain to be solved. One may quite agree with Afanas'yeva and Bakhtin when they claim that certain authors, e.g., Nikanorova (12), fail to distinguish clearly these soils from the chernozems.

Our task is to complete the data already available in the literature on the subject of meadow-chernozem soils in Northern Kazakhstan. We must stress that they differ considerably from the meadow-chernozem soils described by Afanas'yeva and Bakhtin, and by Nepryakhin, which lie farther to the north, beyond the borders of Kazakhstan.

We give the name of meadow-chernozem to soils which represent the first transitional stage from chernozem to meadow and meadow-bog soils. The following stage should be represented by chernozem-meadow soils, as described by the previously-mentioned authors. In our researches in Northern Kazakhstan, we classified the latter with meadow soils, because they are much closer to these than to the chernozems.

In Northern Kazakhstan, the meadow-chernozem soils are most frequent in the northern, more densely forested parts of the Northern Kazakhstan Region. There they are found along the upper terrace of the Ishim River, in forest glades and clearings. These treeless areas, contrasting with areas occupied by birch stands on an underlying soloth soil, correspond to the lowest parts of the lowland plain. Meadow-chernozems are fairly widespread in the nor ern, forested parts of Kustanay and Pavlodar Regions, where they also are associated with the previously-mentioned topographical features.

These soils may occur in large continuous tracts, 2-3 thousand hectares or more in are Sometimes they are found in conjunction with soloths, with grey forest solodized soils, an less often with meadow-bog soils. One shou stress that in these regions, and particularly in the northern parts of Northern Kazakhstan Region, chernozems play a subordinate role and occur only along the crests of the broad gentle rises, the highest points in the plain. More to the south, in the hilly forest (pine-birch) steppe of the Kokchetav upland, and e pecially in the steppe parts of the chernozem zone in Northern Kazakhstan, the amount of meadow-chernozem soils decreases sharply. In the Kokchetav upland, these soils occur in depressions between hills, whereas in the steppes of the Western Siberian lowland they are found in small patches in hollows.

Thus, the meadow-chernozems occur in conjunction with various topographical featu but they are always found at relatively lower altitudes than the chernozems.

Vegetation on meadow-chernozems differs strikingly from that on chernozems. On me ow-chernozem soils, meadow grasses predo inate: couch-grass, meadow grass, brome grass, and others. There is also a conside able admixture of various meadow herbs. O occasional representatives of steppe grasses can be found among this vegetation: feather-grass and fescue grass. Sometimes, especi ly in the north, bog vegetation is also found, small amounts: the reed and the horsetail. Representatives are also found of halophytes chiefly marsh rosemary.

Thus, the vegetation of meadow-chernoze in Northern Kazakhstan is fairly varied, bei an unusual mixture of meadow forms with rtain steppe, bog, and solonchak forms. The ass is thicker than on chernozems. It gives se to a compact sod. In summer, the depressons in the steppe stand out clearly, because their green color, contrasting with their rned-out surroundings. These meadow-cherzems are easily distinguishable from cherzem soils by their natural vegetation.

The morphology of meadow-chernozem can characterized by the following profile:

Profile 21. On the Nezhinskiy grain sovoz, Ruzayevka District, Kokchetav Region. eppe hollows with dense herbage, consisting meadow grasses and mixed herbage, with a nall admixture of feather-grass, fescue, and arsh rosemary. Effervescence in wedges at cm depth, total effervescence at 55 cm pth.

A_0, 0-7 cm. Compact sod, grey-black with cinnamon brownish tinge; clear transition to e next horizon.

A, 7-35 cm. Fine clay loam, grey-black, ghtly granular-blocky, compacted, fissured ward the bottom; clear transition to the next rizon.

B_1, 35-55 cm. Fine clay loam, grey-brown, large blocky, compacted, fissured. Tinted regularly by indistinct streaks of humus; adual transition to next horizon.

B_2, 55-105 cm. Grey-brownish, lighter lor than previous horizon; lumpy-blocky, mpacted. Indistinct streaks of humus conue. From 96 cm downward, carbonate spots. ansition to next horizon gradual.

C, 106(180) cm. Compacted clay, yellowown with bluish tinge, blocky, moist. Sesioxides appear in spots throughout the hori. At a depth of 4 m, fresh water detected manual boring.

Meadow-chernozems differ from the surinding chernozem soils by their more comct sod (which results from a denser vegetan), as well as by a thicker A horizon, a earer transition from horizon A to horizon B, l the absence of well-defined tongue-like eaks in the transitional horizon. The tonguee intrusions of humus, so striking by their rker color in the transitional horizons of ernozems in Northern Kazakhstan, are dife and indistinct in meadow-chernozem soils. the lower part of their profile there are ces of gleization. Borings show that in adow-chernozems the water table is shallow, ile in chernozems it is much deeper.

A certain compactness of the lower part of A horizon and of the entire B horizon, as ll as their fissured state, indicate the solonetzic condition of the soils.

Analyses (Table 1) show that the meadow-chernozems may contain, in their upper horizons, a variable amount of humus, depending upon their texture and on their precise location within the chernozem zone. Fine-textured meadow-chernozems of the more northern region have a higher humus content (Profiles 21 and 144). In all cases, whatever the amount of humus, it decreases with depth much faster than in chernozem soils. As a rule, most of the humus is concentrated in the uppermost horizon. Already in the lower part of the A horizon there is considerably less of it, and very little may be found in horizon B. This explains the much lighter color of the latter horizon.

Usually, appreciable amounts of carbonates are not encountered in the upper horizons. In most cases they are found in horizons B and C, but even there the quantities are generally very small, with a maximum in the lower part of the B horizon or in the upper part of the C horizon. The soil solution is weakly alkaline in the upper horizons and fairly strongly alkaline in the lower horizons. This means that the soils are solonetzic. The meadow-chernozems of Northern Kazakhstan differ clearly in pH from those of the Western Siberian lowland, to the north and outside the boundaries of Kazakhstan; these Western Siberian soils, as described by Nepryakhin (11), show an acid reaction in the upper horizons.

The meadow-chernozems of Northern Kazakhstan contain less nitrogen than the chernozems; consequently, the C:N ratio is larger in the meadow-chernozem than in the chernozem.

Analysis of the water extract and pH determination show that meadow-chernozems are more or less solonetzic. This is also supported, in almost all cases, by the increasing amount of solid residue in the extract in the lower horizons; i.e., by the larger quantities of easily soluble salts and the increase, with depth, of the general alkalinity. However, these phenomena are hardly noticeable in the case of coarse-textured meadow-chernozems (Profile 90).

The solonetzic character of the meadow-chernozem soils is also attested by the presence of appreciable amounts of adsorbed sodium. It is absent only in the soil of Profile 90. The soil in Profile 21 contains less sodium than the soils in Profiles 1 and 142; nevertheless, a comparison between the data on adsorbed sodium with those on the analysis of the water extract indicate the solonetzic nature of the soil in Profile 21.

The total adsorbed bases in meadow-chernozems is somewhat smaller than in chernozems.

Table 1

Basic analytical data on meadow-chernozems of Northern Kazakhstan

Profile No.	Depth, cm	Soil and location of the profile	Humus %	Carbon dioxide, %	pH	Total nitrogen %	C:N	Particle-size analysis		Water extract, %				Adsorbed cations		
								<0.01 mm diam.	<0.001 mm diam.	Solid residue	Total alkalinity	Cl	SO_4	Na, meq	Na, % of total	Total adsorbed cations
21	0—7	Meadow-chernozem, slightly solonetzic fine clay loam. Nezhinskiy sovkhoz, Kokchetav Region. Steppe hollow. Traces of gleization from 106 cm on. Water table at 4 m.	9.09	No effervescence		—		57.2	31.8	0.108	0.023	Traces	0.016	0.90	2.9	30.62
	10—20		5.87	"		—		65.2	37.9	0.072	0.015	"	0.014	0.80	3.2	24.56
	40—50		4.52	1.30		—		63.6	40.3	0.064	0.027	"	0.011	—		
	80—90			4.55		—		60.9	35.7	0.108	0.049	"	0.023	—		
	110—120			6.62		—		63.9	39.7	0.107	0.042	0.004	0.040	—		
	170—180			5.44		—		60.5	31.3	0.208	0.067	0.048	0.010	—		
144	0—10	Meadow-chernozem, solonetzic, fine clay loam. 2 km south of Gavrino village, N. Kasakhtan Region. Slightly elevated forest clearing. Traces of gleization from 90 cm on. Water level at 4.6 m	7.62	No effervescence	7.2	0.36	12.2	—		0.128	0.065	0.008	0,004	—		
	15—25		3.44	"	7.7	0.13	15.3	—		0.766	0.117	0.039	0,002	—		
	40—50		1.45	3.81	8.4			—		0.582	0.091	0.120	0,013	—		
	60—70		0.98	6.89	8.6			—		0.494	0.070	0.182	0,051	—		
	105—115		0.43	3.44	8.7			—		—	—	—	—	—		
1	0—10	Meadow-chernozem, solonetzic, fine clay loam. Sovkhoz Moskovskiy, Akmolinsk Region. Steppe hollow	6.82	No effervescence	—	0.38	10.4	54.8	23.6	0.144	0.025	0.042	0.011	2.09	6.1	34.26
	15—25		3.17	"	—	0.36	5.1	76.7	32.2	0.176	0.035	0.045	0.040	2,78	8.4	33.10
	60—70		1.09	3.6	—	—	—	67.5	30.2	0.278	0.070	0.063	0.054			
	80—90		0.65	5.6	—	—	—	74.2	43.0	0.916	0.020	0.139	0.612			
142	0—10	Meadow-chernozem, solonetzic, fine clay loam. 6 km southwest of Barnevka village, N. Kazakhstan Region. Upper terrace of the Ishim River. Traces of gleization from 70 cm on	4.12	No effervescence	—	0.18	13.2	44.6	17.4	0.152	0.027	0.020	0.002	3.72	13.9	26.74
	10—20		3,87	"	—	0.16	18.9	49.3	18.7	0.102	0.038	0.005	0.001	3,43	17.4	25,43
	25—35		1.99	"	—	—		54.5	22.4	0.168	0.058	0.011	0.001	6.53	26.7	24.45
	50—60		0.38	3.34	—	—		51.8	21.3	0.136	0.060	0.014	0.010	—		
	110—120		0.21	3.17	—	—		50.1	18.0	0.234	0.046	0.026	0.108	—		
90	0—10	Meadow-chernozem, coarse clay loam. Experimental area, Mikhaylovka, Pavlodar Region. Slightly elevated forest clearing. Traces of gleization from 95 cm on. Water table at 4.2 m	3.75	No effervescence	7.1	0.15	14.5	23.3	16.1	0.072	0.023	0.002	0.003	—		17,14
	15—20		2.55	"	7.2	0.13	11.4	23.7	14.8	0.068	0.020	0,004	0.004	—		14,73
	40—50		0.47	"	7.3	—		16.0	11.7	0.062	0.025	0.002	0.002	—		
	80—90		0.43	1.95	7.8	—		14.8	7.4	0.065	0.034	0.003	0.002	—		
	150—160		0.39	1.91	—	—		12.1	9.7	0.007	0.040	0.005	0.001	—		

is total varies according to the humus content
d texture, and is higher in soils which are
e-textured and rich in humus. Most of the
eadow-chernozems of Northern Kazakhstan
e indeed fine-textured. Coarse-textured soil
typical only for meadow-chernozems of the
tysh River region (Profile 90). Lower, espe-
ally transitional horizons (except in coarse-
xtured soils) are distinguished by a finer tex-
re than that of upper horizons. We may infer
at meadow-chernozems have a more or less
early defined illuvial horizon. Its presence
s do the data on the water-extract analysis and
sorbed sodium) indicates that these soils are
lonetzic.

Meadow-chernozems differ somewhat from
ernozems as to the composition of their hu-
us. Table 2, in conjunction with other data
) and Yemel'yanov (8, 9) shows that the ratio be-
een humic and fulvic acids, and the amount of bi-
mens in the humus, are similar in meadow-
ernozems and in chernozems. However, in the
mus of meadow-chernozems, there is less in-
luble residue (humins). The reason is that the
eadow-chernozems receive more moisture than
e chernozems, and their humus remains active
r a longer time. The transformation of humic
ids into humins proceeds more slowly.

Very little study has been devoted so far to
e genesis of meadow-chernozems. Afanas'-
va, Bakhtin (1), and Nepryakhin (11) describe
ese soils without concerning themselves at all
th the question of their origin. Tsyganov (15)
sumes that meadow-chernozems have formed
bogs as a result of the drying process. Ac-
rding to this notion, meadow-chernozems
olve into chernozems, the former being the
erunners of the latter.

We cannot agree with Tsyganov that the dry-
g of bogs may lead to a large-scale formation
meadow-chernozem soils. It would seem
at only the typical meadow soils are formed
by such a process. The meadow-chernozems of Northern Kazakhstan, at least most of them, must have arisen in a different way.

In the past, all of the Kazakhstan portion of the Western Siberian lowland was a treeless expanse; chernozem covered the areas now occupied by meadow-chernozem soils. The advance from the north of trees which colonized the lower and wetter parts of the plain, also favored the development of relatively humid conditions in the more elevated tree-ringed districts. In such districts a meadow vegetation began to appear; a process of evolution began from chernozem to meadow-chernozem. Thus, the advance of forests into the steppe contributed in a crucial though indirect manner to the formation of meadow-chernozem soils. This influence is confirmed by the fact that the vast majority of meadow-chernozems is concentrated within the forest-steppe belt of Northern Kazakhstan, and also by the fact that they appear not only in low-lying, but also in slightly elevated districts of the plain, on condition that the latter are surrounded by trees.

That the meadow-chernozems are not forerunners of chernozems, but on the contrary — that the reverse is true, is proved convincingly by the frequently indistinct tongue-like character of transitional horizons. The chernozems of Western Siberia and Northern Kazakhstan are actually typified by well-marked tongues in the transitional horizon. This is one of the morphological distinctions which set them apart from chernozems in other regions. Several soil specialists assert that this tongue-like character results from a dry and exceedingly continental climate, which causes fissures to appear in the soil along which humus penetrates into the lower horizons. The existence of tongues in meadow-chernozems cannot be explained by the theory of genesis from bogs. Indeed, fissures would not have formed at all in a moist soil. Nor would they have formed, on

Table 2

Chemical composition of humus in meadow-chernozem soil of Northern Kazakhstan

Profile No.	Depth, cm	Designation and location of soil	Carbon %	Humus content in % of total organic carbon of the soil				Ratio of humic acids to fulvic acids
				Humic acids	Fulvic acids	Bitumens	Insoluble residue	
21	0 – 7 15 – 25 35—45	Meadow-chernozem, slightly solonetzic. Sovkhoz Nezhinsk. Kokchetav Region.	5.30 3.44 2.65	40.0 43.8 42.6	23.1 22.9 23.9	3.1 2.5 3.0	27.8 29.0 30.6	1.7 1.9 1.8

a large scale, in a gradual drying process. On the other hand, if we assume that instead of meadow-chernozems we initially had chernozems, which later evolved, tending towards meadow soils because of an increase in moisture, then the presence of indistinct tongues becomes fully understandable in meadow-chernozems. The increased moisture allowed the humus to penetrate downward elsewhere than along the fissures alone. Hence the tongues, so characteristic of chernozems, became gradually indistinct and survived only as relicts.

Furthermore, the theory of a genesis from bogs fails to explain the frequent occurrence of meadow-chernozems in slightly elevated locations: actually, in the chernozem zone of Northern Kazakhstan, bogs are always found in the lower parts of the plain. In other words, these soils must have resulted from the development of chernozems toward meadow soils, under the influence of an invasion of the steppe by trees. Since the vast majority of meadow-chernozems in Northern Kazakhstan are solonetzic, we may assume that they derive in the main from solonetzic chernozems; the latter occurring at relatively lower altitudes than the non-solonetzic chernozems.

The problem of classifying meadow-chernozem is no less complex than the question of its origin. Afanas'yeva and Bakhtin (1) offer a classification of soils, transitional from chernozem to meadow, according to their stage of evolution toward meadow soils; they single out the meadow-steppe chernozems, the meadow chernozems and the chernozem-meadow soils. This classification is based on the water regime of the soil. The level of the water table would be lowest in meadow-steppe chernozems, highest in chernozem-meadow soils. The principle of this classification seems acceptable. However, one may doubt the necessity of singling out the "meadow-steppe chernozems": they are really too close to meadow-chernozem soils, — as may be seen from our data as well as from those of the previously-mentioned authors.

Soils transitional from chernozem to meadow should also be classified according to their degree of salinization and solonetzic condition into: slightly, medium, and strongly solonetzic (or solonchak-like).

At present, the questions of classification cannot be fully answered, because of a lack of full information.

The meadow-chernozem soils of Northern Kazakhstan are highly fertile. Their main advantage over other soils in the zone consists in their better moisture condition. Even in dry years, crops on these soils are less subject to drought. On the other hand, it is erroneous to assert, like Kulakov (10), Panov (13) and the *Instructions for Soil Study of Virgin and Abandoned Lands* (14), that these soils are the bes ones in the entire northern part of the Kazakh SSR. As stated previously, the meadow-cher nozems of Northern Kazakhstan are solonetzi Their structure is less pronounced than in the chernozems, and therefore their physical pro erties are not quite satisfactory. While they retain moisture for a longer period in dry years, they also tend to become excessively wet in years of heavy precipitation. This occurs particularly in the northernmost regions of Kazakhstan, where meadow-chernozems ar most widespread. In wet years, grain crops ripen late; in case of early frosts (frequent in Northern Kazakhstan), this may result in cro losses. In excessively wet years, crops may also be lost by rotting.

In the more southern regions of the cherno zem zone, where meadow-chernozems are located in depressions, such soils may be an ob stacle to cultivation, because in spring, when chernozems are already tillable, these depres sions are still waterlogged.

No doubt, the meadow-chernozems of Nort ern Kazakhstan are by and large tillable and highly fertile; nevertheless, because of the foregoing conditions, one must apply to them an agricultural technique distinct from that which is suitable for chernozems. Moreover, in the northernmost regions, one should selec fast-maturing crops for cultivation.

Because of these circumstances, which ar of great practical importance, the meadow-chernozems should be carefully defined on soi maps, and clearly distinguished from the che nozems.

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SOIL EROSION IN THE MOUNTAIN-FOREST ZONE OF THE CARPATHIANS

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Soil erosion on the slopes of the Carpathian Mountains occurs when timber is cleared from large areas and drag-hauled downhill during summer logging operations. The lumber industry in the Carpathians entirely disregards the harmful effects of present methods in accelerating erosion on the mountain slopes.

We undertook a study to gather quantitative data on soil losses caused by logging operations to show the economic reasons for correcting present methods of forest management and introducing new lumbering techniques.[1]

Methods of Field Research

Areas were selected for study in two geomorphological regions: 1) in the Beskid-Gorgan subregion of the outer Carpathian region, where logging sites were studied in the Delyatinskiy and Nadvornyanskiy leskhozes (forest enterprises); and 2) in the Poloniana-Chernogora geomorphological region where logging sites in the Ravkhovskiy and Svalyavskiy leskhozes were studied.

Differences in geology, topography, and climate, as well as in vegetation and soil, cause differences in erosion in each of these regions. In the Polonina-Chernogora geomorphological region, where thick brown mountain-forest and mountain-podzolic soils predominate, there is intense sheet erosion and scour, while in the Gorgan district of the outer Carpathian region, where stony soils, developed on resistant sandstone of the Cretaceous and Paleogenic flysch (Fig. 1) predominate, there is a special kind of erosion which needs further investigation. We used different methods of study in each of these regions.

In the Gorgan Mountains, where large fragments of sandstone are found on the surface of the slopes, soil losses cannot be any of the accepted methods: gully volume, measuring staffs, or the depth of genetic horizons. Indeed, in this region, a full sequence of soil horizons is often lacking and there are no sign of typical sheet erosion of scour. We find rather an internal soil erosion that involves the removal of humus and fine particles from t soil between the rock fragments.

We studied this type of erosion by weighing, layer by layer, the roots and fine earths from test pits of a given volume. A system of pits was laid out at logging sites and in the forest. Wooden frames 1 m square were laid down at each pit site; the area within the frame was excavated to a depth of 0.5 m; and the herbace and moss cover, the forest litter, the fine ear and roots were weighed. Often at some partic lar depth it was difficult to separate the fine earths from the small gravel (0.5-0.8 cm). In these cases wer resorted to double weighing t get the weight of the fine earths alone. We first weighed a 5 liter cylinder containing soil and gravel, and then weighed the gravel alone after washing. This gave us the volume and weight of the herbaceous vegetation, forest litter, roots, and fine earths at field moisture. We then made reductions to dry weight on the basis of data for dried samples.

Test pits were laid out in series, on the upper, middle, and lower parts of slopes in forested areas, at logging sites with undisturbed surface, and at logging sites with disturbed surface. Efforts were made to obtain complete similarity in exposure, in steepness of slope, in soil, and in forest type. The met and season of timber hauling were also noted. Logging sites were investigated 1, 2, 3 and 10 years after cutting. By comparing the dry weight of humus, roots, and fine earths in 0.5 m^3 holes in forested tracts, at logging sites with undisturbed surface, and at logging sites with disturbed surface, we were able to estimate soil losses caused by the cutting and

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[1] The following participated in the field work: S. V. Shevchenko, A. I. Buteyko, V. K. Myakushko, Yu. A. Yurkevich, V. P. Dzyubenko, L. I. Polovnikov, A. S. Filippov, N. S. Cherkasov, and I. P. Yatskiv.

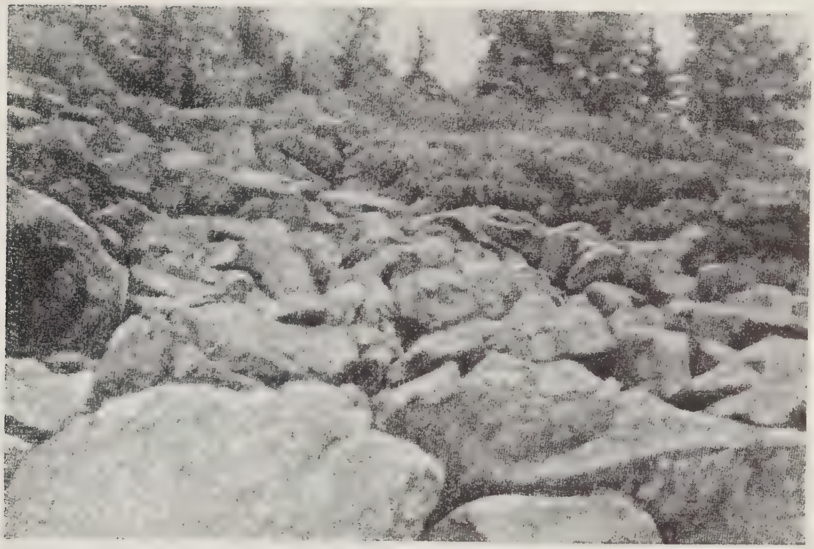

Fig. 1. - The process of overgrowth on sandstone scree: lichens and mosses appear first, then mugho pine, spruce, birch, and other species.

ling of timber.

To parallel our field studies, we initiated
manent studies of erosion on certain areas.
tinuing studies at these sites in the years
come should clarify the dynamics of erosion
umus and fine earths.

In the Polonina-Chernogora geomorphologi-
region (inner anticlinal zone), on slopes
h fairly thick brown forest soils, erosion
s studied as follows. On a recently clear-
area, immediately after the cutting and
noval of timber, or after the lapse of only
or two years, 2 x 2 m experimental plots
re laid out in continuous cross-slope strips
nning the whole logging site. As a rule,
ee strips of experimental plots were laid
at each site: on the upper, middle, and
er parts of the slope. On each experi-
ntal plot, the area covered with herbage
timber debris (but with undisturbed forest
er) was determined together with the area
which the forest litter or the humus horizon
been eroded or otherwise removed, the
a in which the transitional horizon had been
osed, and the area in which the parent ma-
al was exposed. In addition, the width,
gth and depth of any gullies or logging trails
in the experimental plots were measured.
ere eroded soil had been deposited, cuts
e made and the thickness of the deposit
ermined. The volume of deposited soil was
mated from its depth and area.

Pits also were dug, a) in forested areas
ing elevation, exposure, slope, and soil
ilar to those of the logging site; b) at logging sites where the topsoil and forest litter remained undisturbed amid the second growth and scrub, and c) on logging trails of various sizes.

Three to seven cuts were made per logging site. Each pit was described according to the accepted methods, and the depth of genetic horizons was measured. When needed, samples were taken for physical and chemical analysis.

Erosion on Extremely Stony Brown Forest Soils (Gorgan District)

In the Mikulichanskiy forest district of Delyatinskiy leskhoz (quartal 73), soil erosion was studied at three logging sites that had been clear cut (1950, 1952 and 1956). All were located on slopes of 28-35° with southern exposure. The soils are brown forest, slightly podzolized, stony, sandy coarse clay loams. The forest-growth conditions are immature mixed-spruce type[2] (C_2).

The soil profile is exemplified in Profile No. 6, located on a 1952 logging site, under a pile of timber slash running across the slope.

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[2] Soviet foresters classify forest-growth conditions and forest types according to soil moisture into five groups: 1) dry, 2) fresh, 3) moist, 4) damp, 5) wet; and according to soil fertility of soil into four groups: a) poor populated (pine forest), b) relatively poor plant population (mixed pine forest), c) relatively rich (mixed-deciduous, mixed spruce, etc.), d) rich (deciduous, spruce, etc.).

Profile 6. Soil: brown forest, podzolized, gravelly, sandy coarse clay loam.

A_0^1, 0-5 cm. Litter of dry spruce needles, mixed with timber slash.

A_0^2, 5-10 cm. Moist decayed forest litter, dark brown.

A_1, 10-36 cm. Humic eluvial horizon, dark gray with brownish tinge, sandy loam non-compacted blocky-silty in structure with large stones (sandstone), 25-50 cm long.

A_2, 36-56 cm. Sandy loam, light gray, gravelly, with few large stones.

B, 56-78 cm. Sandy coarse clay loam, yellow-brown illuvial horizon, fragile subangular-blocky structure, more compact. Stone inclusions.

Table 1 shows the results of laboratory analyses. The soil is acid and acidity decreases with depth. The humus content is fairly large and decreases gradually downward. In texture, the soil is a silty-sandy loam.

On all three logging sites the timber was logged by horses (on moderate slopes) and by gravity (on steep slopes). On the 1950 logging site the slash was collected in piles along the slope, while on the 1952 and 1956 sites these were laid out across the slope.[3] Our investigations have shown that the earlier piling of slash (along the slope) do not diminish soi losses, while the cross-slope piles of slas are an efficient means of preventing soil e sion.

In the Maksimets-Glodyshchanskiy fore district of Nadvornyanskiy leskhoz, resea on soil erosion was carried out on old logg sites (cut over in 1946-1948), in quartals and 102. As an example, we present data 1947-1948 logging site in quartal 102, whe six profiles were studied.

Profile 12 was used as a control for the upper part of the site. This profile was lo cated 20 meters from the edge of the loggi site in forest of the following composition: 9 Spruce — 1 Beech + Aspen Maple-Fir; ag 60-120 years, density 0.7; site index II. T is abundant second-growth spruce, and occ ionally fir. The 30-33° slope has a southe exposure. The herbaceous and moss cove include bilberry, reed grass, brassy hawk weed, bracken, "kislichka," small-fiber w rush, bed-straw, goldenrod, male fern, b tree fern, Solomon's seal, and the mosses *Dicranum undulatum*, *Rhytiadelphus trigue* and *Hylocomium splendens*.

Profile 12. Soil: brown forest, immatu cobbly. Forest type: 'fresh' Carpathian 'mixed-spruce'.

A_0, 0-3 cm. Forest litter of semi-deca leaves, needles, and branches covering ou cropping stones.

A_1, 3-23 cm. Stones 10-20 cm in diam between them, humus penetrated with root voids.

A_1B, 23-53 cm. Stones 5-10 cm in dia and smaller rubble; in between, fine earth

Table 1

Soil analyses. Profile 6[a]

Horizon	Depth, cm	Hygroscopic moisture %	Humus, % (after Tyurin)	pH of water extract	Particle size-analysis, % Diameter of particles, mm 1.00 – – 0.25	0.25 – – 0.05	0.05 – – 0.01	0.01 – – 0.005	0.005 – – 0.001	< 0.001	Total of fractions <0.01 in diam.	<0.0 in diam
A_1	10 – 36	1.72	7.56	4.9	6.85	62.16	16.16	2.39	3.07	9.37	14.83	85.
A_2	36 — 56	0.65	2.43	5.3	14.99	57.89	10.20	4.72	3.12	8.08	15.92	83.
B	56 — 78	2.33	2.03	6.0	24.72	48.64	13.70	4.38	0.57	7.99	12.94	87.
BC	78 and deeper	2.26	2.61	6.0	14.35	22.47	54.34	0.80	1.81	6.13	8.74	91.

[a] All the soil analyses were performed in the Soil Science Laboratory, Chair of Forestry, L'vov Forest Engineering Institute, by laboratory assistants R. N. Galanets and A. I. Bondar under the direction of V. S. Peshko, director of the laboratory.

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[3] In 1950 we suggested that timber debris on logging sites should be piled across the slope. From 1952 on, this method was widely used at the Nadvornyansk leskhoz by Yu. V. Yurkevich and D. I. Blyusyuk.

ay particles, pierced with roots, but less so an the upper horizon.

Profile No. 13 was located nearby, in a ony area of the 1947-1948 logging site. Slope: -34°, southern exposure. Width of the site, 0 m; length, 400 m. After 10 years, a herceous overgrowth had started with some rubby growth and second-growth tree species. 1956 trees were planted here at a rate of 500 seedlings per hectare, with soil proced for each seedling.

The over-all density of scrub and second owth was 0.2. Red elder and goat willow edominate; there are fewer samplings of rch and aspen, with occasional *selezskaya* llow. The shrubs and second growth are und chiefly at the edge of the forest.

The herbaceous cover is interrupted by re spots; its average density is about 0.4. s much as 40% of the area of the logging site taken up by bare stones of various sizes, to 0.5-0.6 m. The herbaceous vegetation cludes bulrush reedgrass, soft bed-straw, xglove, bilberry, goldenrod, fine petal schia, peach-leaf bellflower, clustered bellower, and dewberry.

Profile 13. Soil: brown forest, cobbly, oded.

A_1, 0-20 cm. Stones 10-25 cm in diameter. umus and fine earths completely eroded from is horizon.

B, 20-50 cm. Rubble and gravel filled with mified brown fine earth, root residues pre- nt.

C, 50 cm and deeper. Soil-forming parent aterial: rubbly compact clay, yellow.

Studies of 17 profiles on stony slopes yielded e following data on the amounts of internal il erosion. In the upper part of logging tes where timber is cut in summer 200-500 etric tons are eroded in 7-10 years or an erage of 30-50 metric tons per year. Soil sses from the lower third of the logging site nount to 400-1300 metric tons in 7-10 years or average of 60-130 metric tons per year from e hectare.

Erosion on Brown Forest Soils, Gravelly Coarse Clay Loam

In the Delyatinskiy leskhoz erosion was udied in quartal 78 of the Mikulichanskiy rest district at a 1954 logging site located on 25-35° northwest slope. Here 7 profiles d 290 experimental plots were studied. We all describe only two profiles: Profile 21 a site with undisturbed soil, and Profile 22, on a timber-logging trail.

Profile 21. Soil: Brown forest, slightly podzolized, stony, coarse clay loam. Forest-growth conditions: C_2 — immature mixed-spruce type.

A_0, 0-5 cm. Forest litter of semidecayed needles, small branches, and moss.

A_1, 5-17 cm. Humus horizon, dark gray with brown tinge, coarse clay loam, mellow, fine blocky, pierced with roots. Gradual transition. Stone inclusions.

A_2, 17-25 cm. Humic-eluvial, gray with brown tinge, pierced with roots. Clear transition. Stone inclusions.

B_1, 25-30 cm. Transitional horizon, dark brown, compact, with humic intrusions. Stone inclusions.

B_2, 30-49 cm. Transitional horizon, lighter in color, light brown. No roots. Stone inclusions.

BC, 49 cm and deeper. Transition to the parent rock, yellow, sandy loam.

Table 2 shows the results of laboratory analyses. The soil is acid. Acidity decreases with depth (from pH 4.7 to pH 5.6). Humus content is high in the upper horizon (12.59%) but decreases gradually to a minimum in the BC horizon (0.68).

The soil texture in Profile 21 may be described as sandy silty coarse clay loam. In contrast to typical brown soils, there is here a redistribution of colloids within the soil profile. They are least concentrated in the A_2 horizon.

Six meters away from Profile 21 another profile (No. 22) was studied on the main logging trail.

Profile 22.

B_1, 0-4 cm. Discontinuous (in places), dark brown, compact.

B_2, 4-25 cm. Brown; stone inclusions.

BC, 25 cm and deeper. Transitional to parent rock, yellows, sandy loam.

Comparing Profile 21 (undisturbed soil) and Profile 22 (on the logging trail), we see that the latter profile is much truncated, having lost its upper horizons. On the logging trail there is no humus horizon (which should have been up to 20 cm thick), and part of the upper layer of the transitional horizon is also absent.

Table 2

Soil analyses. Profile 21

Sample taken at	Horizon	Depth, cm	Hygroscopic moisture, %	Humus, % (after Tyurin)	pH of water extract	Particle size-analysis, %						Total of fractions	
						Diameter of particles, mm							
						1.00–0.25	0.25–0.05	0.05–0.01	0.01–0.005	0.005–0.001	<0.001	<0.01 mm in diam.	>0.01 mm in diam.
Logging site, where the soil is undisturbed and not eroded.	A_1	5—17	3.61	12.59	4.7	6.53	43.87	30.32	2.15	5.85	11.28	19.28	80.72
	A_2	17—25	2.98	8.10	4.3	7.68	59.19	18.45	3.02	6.44	5.22	14.68	85.32
	B_1	25—30	2.18	4.47	4.7	10.19	58.81	15.90	3.10	4.99	7.01	15.10	84.90
	B_2	30—49	1.96	2.36	5.1	11.61	59.90	17.82	5.27	2.04	6.36	13.67	86.33
	C	49—59	0.77	0.68	5.6	15.24	65.32	2.88	3.16	2.00	11.40	16.56	83.44

Table 3

Soil losses, two years after logging operations, in cubic meters per hectare

Location of experimental plots	Displaced and eroded		Deposited soil
	Forest litter	Soil	
Upper third of logging site (18-20° slope)	56	106	31
Middle of site (25-32°)	143	273	45
Steepest part of slope (30-35°)	223	445	—

In addition to the pits we also laid out experimental plots on various parts of the slope. Table 3 shows the damage to the soil, as estimated from the plots.

Thus, two years after timber was cut, soil losses reach a maximum of 440 m³ per hectare (or 670 m³, including the forest litter), even though the logging site is intersected by ravines, it has no long length of runoff, and is obstructed by much logging debris.

On the Rakhov leskhoz, in quartal 2 of the Bogdansk forest district, the 1956 logging site was studied one year after felling operations. Timber was skidded out by gravity (see Fig. 2). The site is 12 hectares in area and adjoins the 1955 logging site. Both sites have since been reforested. The area slopes in a generally southeastern direction, but the topography of the site is complicated by a deep ravine and several shallower ones, so that there are also south and east slopes. Steepness varies from 25° to 40°. The south slope has less herbaceous growth and is more eroded. Erosion is striking in tree plantations, where the soil has been loosened around the seedlings.

The herbaceous growth is irregular. On the steeper slopes its density reaches 0.3; on the gentler slopes, 0.7-0.8. It consists chiefly of Ivan's tea, coltsfoot, woodruff, lungwort, dewberry, lady fern, touch-me-not, neetle, bed-straw, and fine-petal fuschia.

Six profiles were taken in a clear-cut are and one under forest cover which serves as a control.

Profile 26 is in a forested area having the following composition: 6 Spruce, 3 Pine, 1 Beech + Maple; age 80-100 years; site index Ia; density 0.7. Stand has occasional seedlin of beech fir and spruce. There is much win fall. Slope: 30-35°, exposure SSE. In the vegetation cover one finds mostly: red raspberry, strawberry, wood lettuce, lady fern, male fern, and Archangel dead nettle.

The soil is a fine gravelly, brown forest soil on diluvial shales. The forest type is immature Carpathian beech-fir mixed-spruc type.

The upper horizon contains much humus (19.10%); but the amount decreases sharply i the lower part of this horizon, (3.95%). The minimum amount is found in horizon B (2.18

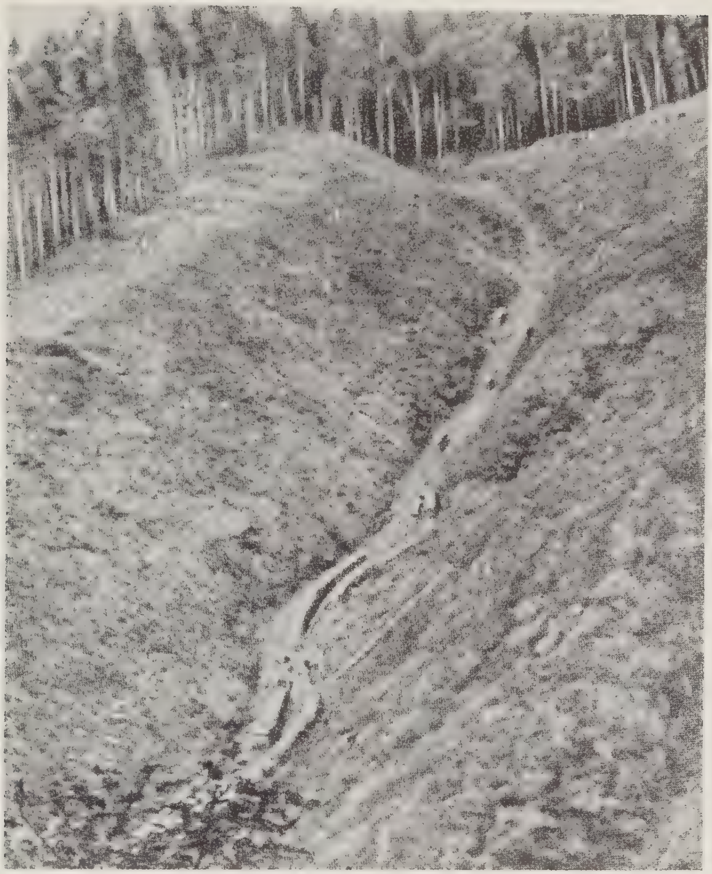

Fig. 2. - General view of the forest-steppe, one year after timber felling. Rakhovskiy leskhoz, Transcarpathian Region.

for the BC horizon, it contains a fairly high nus percentage (3%). In texture, this soil y be called silty-sandy coarse clay loam.

Brown forest soils of the Carpathians are eed characterized by a high content of humus he upper layer of their humus horizon (15%-). This has been noted not only in our own dies, but also in those of Andrushchenko Zrazhevskiy (2), Pasternak (3), and others. less typical is the fact that the horizon transi- al to the parent rock (BC) does not differ n this parent material in morphological ts, including color. It is only laboratory lyses which disclose its relatively high con- of humus (up to 3%). Because of the high meability of these soils, humic substances washed into the parent material. They are resented by fulvic acids which very slightly r the parent material.

rofile 30 is located in the lower part of the ging site, on the eastern slope of a ravine ning across the site. Here, the A_0, A_1 and part of the A_2B horizons were displaced during logging and then eroded, so that the soil profile has been reduced by 18 cm. In addition, the 3-cm forest litter was removed here entirely. Consequently, one year after felling, a considerable amount of soil and forest litter is being eroded, in spots, from the lower part of the site also. On the other hand, Profile 31 (60 m from the upper edge of the forest) shows that on small-size logging sites the soil should not be appreciably eroded, because there the soil cover is only slightly disturbed by logging operations, and water erosion does not occur.

In addition to the profile cuts, 287 experimental plots were laid out at the previously mentioned logging site on various parts of the slope. Results are given in Table 4.

These data show that where timber was logged in summer 350 to 670 m^3 of soil per hectare were lost in one year.

In the Slavyanskiy leskhoz, quartal 7, in-

Table 4

Soil losses, one year after logging operations, in cubic meters per hectare

Location of experimental plots	Area of damaged soil surface, %	Displaced and eroded		Deposited soil and litter
		Forest litter	Soil	
Upper third of logging site	45	140	353	—
Middle part of logging site	54	101	420	50
Lower third of logging site	60	97	670	250

vestigations were carried out at a recent (1957) logging site (cutting was started in 1956, ended in 1957, debris cleared in 1957). This site is located on the uppermost part of the slope; its upper limit coincides with the upper limit of the forest at the "Stoy" polonina.[4] Nothing justifies the choice of a logging site at such high elevations (1100-1200 m), and it will be difficult to reforest it (the site is unprotected against winds and blowing snow from the "poloninas").

The triangular logging site is 22 ha in area. Its width at the base is 650 m, its depth (the height of the triangle) is 700 m. The slope is 30-32°, with southern exposure. The soil is brown forest, medium stony, deep, coarse clay loam. Forest-growth conditions are of the immature mixed-beech type.

Judging by the pH of the water extract, the soil under forest conditions is slightly acid. The humus content (5.82%) of the A horizon is lower than at previously described logging sites. It decreases gradually with depth. Here too, the BC horizon, which is transitional to the soil-forming parent rock, contains a fairly large amount of humus (2.40%). As to texture, this soil is a silty-sandy coarse clay loam. The colloids are distributed evenly throughout the profile.

Conditions after felling and logging vary widely in various parts of the site. In some places the soil is undisturbed and deposition is neglibible. In many places, where both soil and forest litter were displaced and where many logs were skidded, the upper layers of soil have been completely removed.

Table 5 shows the amounts of soil erosion at test plots.

Although this logging site was not particularly steep, losses of soil and forest litter by July had reached 300 m³ per hectare. According to Polyakov (4), annual soil losses (in areas completely cleared of timber) reach 150-250 m³.

General Results

On clear-cut forest sites, soil erosion sh ly decreases after the third or fourth year of cutting because of overgrowth. Thereafter i tapers off gradually, as the new growth increases in density and thickness (Fig. 3). On stony soil, erosion tapers off particularly slowly.

On the slopes of the Carpathian range, de fairly good hydrophysical conditions, large s losses occur (Table 6).

The favorable properties of forest soil ar largely offset, when timber is clear-cut ove large areas in snowless periods. The fallin timber heavily damages and compacts the soil by its impact. The steeper the slope, the stronger the impact and compaction. Ti falling down slope acquires tremendous ener from gravity and skids, carving out furrows gullies. Undoubtedly, if timber were felled across the slope, the damage would be considerably less.

Especially destructive in mountain areas are logging operations in snowless periods; the forest litter is disturbed together with th upper, most fertile layer of soil, which has the best hydrophysical properties. Moreove the logging causes compaction of the soil on trails. The water intake of the soil decreas by a factor of 30, 40, or more.

Soil erosion is considerably less, or doe not occur at all, on small logging sites (no more than 4-5 ha), chosen with due regard t topography. Likewise, soil erosion will be minimized if logging operations are carried out in snow.

If soil erosion caused by present method of logging are taken into account, the cost of mountain timber should be estimated at t

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[4] In the Carpathians, subalpine (high-altitude) meadows are called poloninas.

Table 5

Soil losses, one year after logging operations, in cubic meters per hectare

Location of experimental plots	Area of damaged soil surface, %	Displaced and eroded		Deposited soil and litter
		Forest litter	Soil	
Upper third of logging site	24	35	58	—
Middle part of logging site	67	88	174	21
Lower third of logging site	81	158	145	32

e figure now claimed by lumber producers.

Conclusions

1. Clear-cutting of timber over large areas summer leads to soil erosion, which be-mes enormous after logging operations.

2. On the slopes of the Carpathian, when own forest and mountain podzolic soils are ick enough, sheet erosion and scouring appear after logging operations.

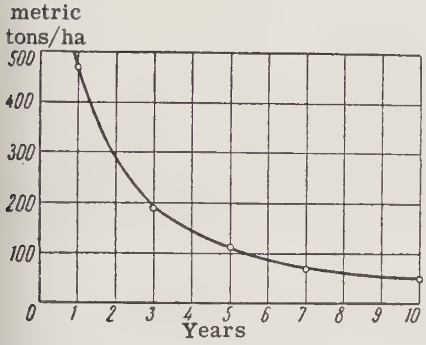

Fig. 3. - Erosion intensity as a function of the age of the logging site.

3. On cobbly (skeletal) soils, internal soil erosion predominates. The danger here is that all the fine earths accumulated over thousands of years are eroded, so that the soil-forming process has to start again from zero. In such circumstances, timber felling should be prohibited altogether (both complete clear-cut and cutting combined with planting).

4. In order to prevent erosion and improve water-retention and soil conservation in the Carpathian mountain forests, logging by surface trailing must be inter-dicted during snowless periods. New techniques of logging must be developed. To conserve the soil, new regulations should be applied to governing timber-cutting permits. Also, new programs should be set up for reforestation and lumbering, in order to interest the lumbermen in the conservation of soil and the regeneration of forests.

Table 6

Some hydrophysical properties of brown forest soils

Horizon	Bulk density	Total porosity	Infiltration coefficient, cm/hour[a]
Humus horizon	0.87—0.98	63—65	40
Transitional horizon	1.10—1.19	57—60	30

[a] Determined in the field laboratory of I. M. Litvinov. Under natural conditions in skeletal soils, the coefficient will be much higher; for technical reasons, we had to take samples with a lower skeletal content.

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IE FIRST STAGES OF WEATHERING AND SOIL FORMATION N IGNEOUS ROCKS IN THE TUNDRA AND TAIGA ZONES

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The theories of Russian scientists on the
ducts of the first stages of soil formation
l weathering of igneous rocks are reflected
most classifications — endodynamomorphic
l endogenic soils (6), incomplete skeletal
ls (16), coarse skeletal soils (7), primitive
umulative soils (9, 14), fragmental soils
4, 5), and primary soils (3, 13).

In our opinion, primary soils and primitive
umulative soils are the best terms. The
st term stresses that the material formed
alteration of igneous rocks is primary in
racter as compared to all other products
soil formation (eluvial and deposited). The
ond brings out the thinness and slight
ferentiation of the soil layer and its pro-
nced accumulative character (as regards
organic matter, clay, and ash elements).
wever, these terms do not express the di-
t and close relation of the soil being formed
h its igneous parent material. We suggest
following term as fully descriptive of these
ls in the first stages of formation — primary
umulative-lithomorphic soils.

The data presented in this paper describe
stages of weathering and soil formation
tinguished by us in the following districts:

1. Bol'shoy Lyakhovskiy Island, in the New
erian Islands, 73°22'N. Samples were col-
ted on granite butte outcrops on the Kigil-
h peninsula (Profiles 188, 189, 84, 86).
cording to accepted classification, this
nd belongs to the arctic desert zone.

2. Lower Indigirka River, 71°N, on the sum-
of Mount Kotel (elevation 341 m), in the
ss-lichen subzone of the tundra. The moun-
top is covered with andesite fragments
h small patches of primary soil between
m (Profiles 45, 47).

3. Eastern Sayan, the upper reaches of the
m-Balyk River (1870 m elevation). Samples
e collected in the mountainous belt of the
er boundary of the forest (mountain forest-
tundra) on a basaltic lava flow (Profiles 41, 42, 44).

We distinguished two phases of primary soil formation in the regions studied.

Phase I, primary soil formation. The upper layer of the rock is loosened and covered with various kinds of crusts and films, usually composed of scaly and leafy lichens, coatings of so-called "desert varnish," and loose, eluvial weathering crusts. All of these are ordinarily found at site of formation. Our data on the weathering of basalt and granite show typically an eluvial weathering crust, that is, a weathered, cracked surface layer with no vegetation.

Phase II, primary accumulative-lithomorphic soils. In this phase fine-earth forms and accumulates in depressions and fissures of the rock, under a cover of scrubby lichens, mosses, higher plants, and sometimes trees. Processes of disintegration and alteration *in situ*, directly under the soil layer and under the vegetation, are by far the most important in the formation and development of primary soils. At the same time, microdiluvial movements of products of the first stage of soil formation, which are small considering the area involved but theoretically important, play a significant part in the initial accumulation of fine earth in the depressions of the rock. These microdiluvial processes, occurring on the watersheds, are characteristic of the first stages of weathering and soil formation.

The phase of primary soil formation, with its crusts and films of different origin and composition at the three sites, is still quite similar morphologically.

Films of scaly and leafy lichens cover considerable areas of rock with a uniform distribution of species (*Gyrophora*, *Acadospora*, *Rhizocarpon*, *Parmelia*, and others).

Rocks not covered by vegetation weather without the participation of visible organisms;

the process is different on different rocks. A weak fractured layer 2-3 cm thick forms on flat rounded surfaces of granite blocks (Bol'shoy Lyakhovskiy Island). Rock fragments and large mineral nodules are fissured and colored reddish brown by thin films and bits of iron and manganese oxides throughout the layer. The surface of more uniform and fine-grained rocks such as andesites (lower Indigirka) and basaltic lavas (Eastern Sayan) is considerably less cracked; boulders are usually covered by a thin, ocherous brown, sometimes reddish, loose crust, from 2 or 3 mm to 1 cm thick. Fine andesite and basalt gravel loses its solidity and initial color, and turns brown. We collected samples of these sorts to show the different types of weathering of the various types of rock. The rock samples were sectioned to determine their mineralogical composition.

The plagiclase granite of Bol'shoy Lyakhovskiy Island has a typical granitoid texture. The content of the constituent minerals varies in different places; the average composition is: orthoclase 40%-44%, plagioclase (oligoclase No. 30), 21%-25%; quartz, 25%-33%; biotite (with iddingsite and chloritized areas), 3%-5%; accessory minerals (mostly zircon), 0.2%-0.3%. The orthoclase is in large grains (0.3-0.8 mm in diameter) with perthitic plagioclase inclusions; many of the grains (40%-50%) are pelitized, while in strongly weathered granites pelitized grains are somewhat more common. The plagioclase is in smaller grains (0.2-0.3 mm in diameter), occasionally sericitized. The quartz grains are comparatively large (0.2-0.5 mm in diameter).

In the andesite from Kotel Mountain, the chief constituent minerals are pyroxene, plagioclase (andesine), and a vitreous, slightly recrystallized matrix. In strongly weathered rocks the pyroxene is very strongly chloritized. The plagioclase is zonal, occasionally strongly sericitized.

The red and rust-red crusts on andesite and granite fragments were identified as limonite; in many cases manganese hydroxides were also present.

The Eastern Sayan basaltic lavas (2) have a porphyritic texture with inclusions of rhombic pyroxene. The matrix is composed of thin, needle-like plagioclase crystals (labradorite No. 60). The interstices are filled with a dark vitreous mass (pyroxene 25%, plagioclase 40%, vitreous mass 35%).

The mineralogical changes in weathered fragments as compared with "fresh" rock are usually slight. Sericitization and pelitization of feldspars may be caused partly by weathering. The principal products of change in the first phase of weathering and soil formation are yellow-brown, rust-colored, and red fil and crusts on the surface of minerals and in fissures.

Let us consider the analytical data for th first phase of formations of films and crusts the rock surface (Tables 1 and 2).

Samples of minimally weathered rocks (g ite, andesite, and basalt) and weathered are covered with reddish brown and brown films were analyzed.

Comparison of the total chemical compos tion of weathered granite from Bol'shoy Lya hovskiy Island and basaltic tuff lavas from t Eastern Sayan with unweathered rock shows removal of alkalis and calcium. The sampl of weathered rock are characteristically so what enriched in Fe_2O_3 and Al_2O_3 and the SiC R_2O_3 ratio is reduced. The removal of base from weathered granite lowers the pH of the suspension of the rock powder and increase the hygroscopic moisture content, the igniti loss, and the amount of Fe extracted by Kir sanov's method. The weathering of the vari kinds of andesite is similar.

The second phase of weathering and soil mation in the districts described is marked primary accumulative-lithomorphic soils of varying thickness, filling niches and depres sions in the surface of the rock.

Bol'shoy Lyakhovskiy Island is the summ of a granite mountain; the surface of the roc is covered with isolated patches of primary soils. There is a moss-lichen cover (Aulacomnium, Camptotecium, Politrichem alpi Cetraria, Thamnolia, Duphourea).

Profiles 84 and 189. The entire soil pro file is 5-15 cm thick, composed of dark-cin mon brown sandy loam or coarse clay loam fine earths with a high content of coarse organic matter, dead plant remains and grani gravel; underlain by a fissured granite laye

In places well protected against removal blowing, thicker primary soils have develo under herbaceous sod containing mosses an lichens (Lusula confusa, Poa artica, Salix polaris, Polytrichum alpinum, Drepanocla Cetraria nivalis, Duphourea).

Profile 188 is under a grass cover with patches of moss and lichens.

0-6 cm. Dark-cinnamon-brown sod wit granite gravel, thickly interwoven with roo

6-16 cm. Dark-cinnamon-brown sandy loam fine-earth, large amounts of plant re dues, roots and granite gravel.

16-36 cm. The same, but more gravel

Table 1

Chemical data concerning weathered granite and andesite

Sample	Hygroscopic moisture	Ignition loss	Organic matter, % (after Tyurin)	pH		Iron, mg/100 g (after Kirsanov)
	In %			Water suspension	Salt extract	
Bol'shoy Lyakhovskiy Island						
Veathered granite	0.21	0.48	0.28	5.2	4.2	5.0
Minimally weathered granite	0.08	0.37	0.16	6.3	4.8	2.5
Lower Indigirka River (Kotel mountain)						
Strongly weathered andesite	1.76	1.54	0.46	5.9	4.3	20.0
Veathered andesite	0.52	1.04	0.24	5.8	4.1	7.5
Minimally weathered andesite	0.53	1.45	0.30	5.9	4.2	5.0

nes.

36-42 cm. Coarse stones and granite avel covered with cinnamon-brown red crusts edominate; sandy loam fine-earths between gravel. Underlain by a fissured granite er.

Profile 86, same location as Profile 188.

3-14 cm. Dark-cinnamon-brown sod with bble and gravel.

14-26 cm. Dark-cinnamon-brown sandy m fine-earth with abundant coarse organic tter, much granite gravel and rubble.

26-35 cm. Gravelly, sandy loam cinnamon-own fine earth with many large stones and gments. Underlain by a fissured granite er.

The flat top of Kotel Mountain in the lower igirka region, is covered with loose stones, l there are separate, small patches of dense (5-15 cm) shrubs, mosses and lichens.

Profile 45. Under a dense moss-lichen er with patches of Salix polaris.

0-20 cm. Areas of mellow cinnamon-brown dy loam or coarse clay loam fine-earths ween stones.

Profile 47. Under a dryadaceous curtain ias punctata, Cetraria, Alectoria).

2-9 cm. Dark-cinnamon-brown, loose, dy loam fine-earth interwoven with roots, ch gravel with ferruginous films on their faces.

9-24 cm. Dark brown, coarse clay loam, nified fine-earth found in pockets between stones, few roots, underlain by large rocks.

The surface of the lava flow in Eastern Sayan (elevation 1870 m) is covered by a sparse forest of Siberian pine and larch with a shrub moss-lichen vegetation; large patches of exposed lavas alternate with vegetation-covered patches occupying 30%-40% of the lava-flow.

Profile 41. Under a moss-lichen cover (3-5 cm thick, green mesophilic mosses and Cladonia)

0-3(5) cm. Dark cinnamon-brown, clay loam fine-earth with a very high content of coarse organic matter between lava blocks, interwoven with dead moss.

Profile 44. Under a curtain of vegetation (Mongolian tea, bog whortleberry, red billberry) 15-20 cm high, mosses, and lichens.

0-5 cm. Similar to Profile 41, but profusely interlaced with shrub roots.

Profile 42. Under Siberian cedar with a shrub and moss vegetation (Mongolian tea, red billberry, green mosses) cover 70%-85%; the shrubs are 20-25 cm high.

0-2 cm. Dark cinnamon-brown half-decomposed moss-lichen mat with a small amount of clay loam fine-earth.

2-4 cm. Cinnamon-brown coarse clay loam between lava layers, many roots.

4-24 cm. Brown clay loam in hollows and fissures of lava.

Let us examine these data without considering the changes that occur at different stages of development and in the different horizons of the primary soils. We shall regard only their

Table 2

Total chemical composition of primary soils and weathering products

Profile No.	Primary soils	Depth, cm	Hygroscopic moisture	Ignition loss	In % of ignited weighed portion										
			In %		SiO_2	Fe_2O_3	Al_2O	CaO	MgO	K_2O	Na_2O	P_2O_5	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{Al_2O}$	$\frac{SiO_2}{R_2O_3}$
	On granites of Bol'shoy Lyakhovskiy Island														
188	Under a cover of grass -lichen-moss	0—6 6—15 20—30 36—42	9.00 3.42 4.30 3.41	45.03 32.47 24.81 15.20	70.00 70.02 67.01 72.62	5.09 4.90 6.66 5.36	16.88 17.31 20.53 15.72	5.67 5.06 3.64 3.78	Not det'd. 2.11 0.97 1.02	0.91 1.07 1.23 1.58	1.64 1.19 1.44 Not det'd	Not det'd. " " "	32.9 38.1 26.7 36.1	7.1 6.9 5.6 7.9	5.8 5.8 4.5 6.5
189	Under moss-lichen Weathered granite[a] Non-weathered granite[b]	0—12 — —	2.39 0.20 0.05	13.80 1.11 0.42	72.01 73.45 72.27	9.03 2.43 2.21	11.55 15.59 15.11	3.49 2.67 3.57	1.15 0.95 0.79	1.24 2.41 3.68	1.69 1.27 2.29	Not det'd. " "	21.3 80.5 87.5	10.1 8.0 8.2	7.1 7.3 7.5
	On basaltic lava of Eastern Sayan														
42	Under Siberian pine	0—2 2—4 10—24	7.90 7.44 10.00	76.91 53.44 30.50	51.83 52.26 46.20	13.77 14.64 14.05	24.94 22.66 33.90	3.04 2.75 2.93	4.07 3.53 4.03	0.78 0.32 0.05	0.63 0.34 0.17	Not det'd. " "	10.0 9.6 8.7	3.5 3.9 2.0	2.6 2.8 1.8
44	Under moss-shrub	0—5	11.45	73.48	52.98	13.99	20.74	4.14	3.84	0.87	0.68	1.05	10.0	4,5	3.9
41	Under moss-lichen Weathered basalt[a] Non-weathered basalt[b]	0—3 — —	9.24 1.02 0.20	47.30 3.19 0.18	51.60 47.91 49.92	12.37 12.14 11.07	25.42 19.69 18.67	4.04 8.24 8.80	4.06 8.01 8.84	0.34 0.72 0.90	0.49 1.00 1.46	0.87 0.62 0.65	11.1 10.0 11.8	3.4 4.1 4.5	2.6 3.0 3.3

[a] The samples were taken from exposed rocks not covered by vegetation.

[b] The samples were taken from the interior of large boulders after splitting.

eneral features as the first results of changes ı the igneous rock.

In texture, these soils are gravelly sandy oams and coarse clay loams, except for the oils on basalt, which are approximately nedium clay loams (Table 3). The soils are nost gravelly and contain a large amount of nedium sand on the coarsest-grained rocks granites). The amount of gravel and medium and increases with depth, and the clay fracon decreases. This is characteristic of rimary soils developed on massive rocks and proves that they developed in situ. The clay content in these soils is usually small, fluctuating on the average between 5% and 12%. Only in the upper horizons of soils on basalts does it reach 18%-23%. Large amounts of organic matter are present everywhere in the clay fraction, as shown by the data on the clay content after treatment with H_2O_3. The data on ignition losses and the content of organic matter demonstrate the important role of the latter in the composition of the fine material of these soils (Table 4).

Table 3

Particle-size analysis of primary accumulative lithomorphic soils, in % (Analyses by S. P. Ellin)

Profile No.	Primary soil	Depth, cm	Gravel and fragments >1 mm, diameter, % of total weight	Loss by treatment with HCl, %	Particle diameter, mm							
					1−0.25	0.25−0.05	0.05−0.01	0.01−0.005	0.005−0.001	< 0.001	<0.001 after treatment with H_2O_2	<0.01
On granite of Bol'shoy Lyakhovskiy Island												
188	Under herb-moss lichen	0—6	30	4.14	29.3	5.9	31.1	8.8	0.9	19.9	Not det'd.	30
		6 −12	50	4.88	25.3	19.3	34.4	4.6	0.1	11.2	"	15
		20−30	70	4.52	39.7	8.9	23.8	9.1	6.0	9.0	"	24
		36—40	80	4.55	56.6	9.4	10.2	8.2	0.5	10.5	"	19
86	Under herb-moss lichen	3—10	30	2.1	23.8	32.5	24.3	0.1	9.1	8.1	0.4	17
		15—20	63	1.2	49.2	6.5	26.2	3.3	5.9	7.7	0.6	17
		25—30	78	1.6	53.0	6.5	24.5	3.3	6.4	4.8	1.2	16
84	Under moss-lichen	0—2	55	1.1	38.6	13.1	29.9	3.6	5.9	7.7	2.6	18
		2−5	68	1.5	50.7	9.1	27.2	0.1	6.5	5.1	1.2	11
189	Under moss-lichen	0—12	Not det'd.	2.09	52.3	14.2	13.0	5.4	1.2	11.8	Not det'd.	
On andesites in Lower Indigirka River												
47	Under moss-dryadaceous vegetation	2—9	Small amt. of gravel, course fragments	1.7	17.0	29.4	36.4	7.0	1.3	7.0	0.9	15
		9—24		2.5	12.0	24.3	34.9	8.5	11.2	6.6	2.3	27
45	Under moss-sod	0—20	30 %	1.9	13.4	25.4	38.8	8.0	4.5	8.0	2.5	20
On basalts in Eastern Sayan												
42	Under Siberian cedar	0—2	Small amt. of gravel, fragments	13.5	0.8	35.9	17.9	3.7	5.7	22.6	Not det'd.	32
		2−4		13.1	1.7	20.1	18.3	8.5	19.6	18.6	"	37
		10—24		20.1	4.1	4.3	27.3	13.1	20.8	10.3	"	44

Table 4

Chemical composition of primary accumulative-lithomorphic soils. (Analyses by G.G. Rusakova, N.A. Tyapkina, and V.F. Mochalova)

Profile No.	Primary soil	Depth, cm	Hygroscopic moisture %	Ignition loss, %	pH		Organic matter, % (after Tyurin)	Adsorbed cations, meq					Hydrolytic acidity, meq
					Water suspension	Salt extract		Ca++	Mg++	H+	Total	H+, % of total	
	On granites of Bol'shoy Lyakhovskiy Island												
188	Under herb-moss-lichen	0—6	9.00	45.03	Not det'd.	3.6	39.85	31.98		Not det'd	31.98	Not det'd.	42.6
		6—12	3.42	32.47	"	3.5	31.10	11.21		"	11.21	"	39.5
		20—30	4.30	24.81	"	3.4	18.20	3.79	6.22	"	10.01	"	51.2
		36—42	3.41	15.20	"	3.5	6.48	2.74	3.29	"	6.03	"	43.4
86	Under herb-moss-lichen	3—10	5.08	31.08	3.9	2.8	29.18	4.46	2.48	12.1	19.04	63	44.6
		15—20	4.27	Not det'd.	4.2	3.2	21.32	3.35	1.35	8.4	13.12	64	28.2
		25—30	2.32	"	4.2	3.3	12.42	2.11	0.96	5.2	8.27	63	9.3
189	Under moss-lichen	0—12	2.39	13.80	Not det'd.	3.8	7.43	9.60		Not det'd	9.60	Not det'd.	48.7
84	Under moss-lichen	0—2	4.44	20.63	4.0	2.8	16.51	2.46	1.96	11.0	15.4	71	18.8
		2—5	3.10	14.55	3.9	2.8	12.18	1.14	0.95	9.4	11.5	82	14.9
	On andesites on Lower Indigirka River												
47	Under moss-dryadaceous	2—9	4.14	23.41	4.5	3.6	17.71	10.82	2.15	6.1	18.07	34	12.5
		9—24	3.01	13.34	4.6	3.6	9.0	1.9	0.96	5.7	8.6	66	9.9
45	Under moss-lichen sod	0—20	3.67	17.32	4.6	3.6	12.77	6.47	1.56	5.6	13.6	41	15.0
	On basaltic lavas of Eastern Sayan												
42	Under Siberian cedar	0—2	7.90	76.91	4.3	3.0	61.3	11.3	3.8	31.6	46.7	67	Not det'd.
		2—4	7.44	53.44	4.3	3.2	47.7	4.39	2.37	26.9	33.7	72	"
		10—24	10.00	30.50	5.1	4.4	21.5	1.12	0.68	11.3	13.1	93	"

All these soils have acid and strongly acid eactions (the pH of the water suspension is 0-4.5, and that of the salt extract is 2.5-4.0). ne value for the total adsorbed cations is nall, with adsorbed hydrogen predominating p to 70%-90%), and hydrolytic acidity is high. ne degree of base saturation is very low, de-reasing with depth, as is characteristic of imary soils.

Soils developed under moss-lichen on gran-es (Profile 84) and on basalts (Profile 42) e most acid and least saturated. The reason r this is probably the small quantity of bases the ash of mosses and scrubby lichens.

The total chemical composition of primary ils developed on granites and basalts shows veral substantial changes as compared with e parent rocks and the very first products of eathering (Table 2).

All the primary soils are somewhat lower potassium and sodium than the parent ma-rials; in the soils on the granites of Bol'-oy Lyakhovskiy Island (Profile 188) the kali content increases with depth, since the lower horizons there is more medium -0.25 mm in diameter) and, rich in alkaline ldspars. In the primary soils on basaltic lava Eastern Sayan, there is a small accumula-on of alkalis by biogenic processes in the per horizons, but even there the total amount less than in the parent material. Apparent-, even though alkalis, especially potassium, cumulate in the plant ash, they are quickly moved from the primary soils.

The distribution of alkaline-earth elements the primary soils is somewhat different. the upper horizons of the soils developed on e granites of Bol'shoy Lyakhovskiy Island, nich are relatively low in alkaline earths rofiles 188, 189), there is a biogenic accumu-tion of calcium and magnesium under herbace-is vegetation. Calcium and magnesium are so low in the primary soils developed on the salts of the Eastern Sayan. This results om more intense leaching of calcium and agnesium and a smaller accumulation of ese elements in the basic moss-lichen vege-tion of the primary soils in the mountain ndra.

The soils are markedly enriched in Fe_2O_3 d Al_2O_3 in comparison to both fresh and eathered rock, and the molecular $SiO_2:R_2O_3$ tio decreases from the rock to soil.

The data show that the products of the first ages of weathering and soil formation in all ree parts of Eastern Siberia are somewhat milar. The primary soils of the arctic serts, the moss-lichen tundra, and the ountain forest tundra of the Eastern Sayan e very stony, have a high content of organic matter in the fine-earth, have a strongly acid reaction, and have a low degree of base saturation that increases with depth. The soils are usually somewhat low in K and Na (and sometimes also in Ca and Mg), rich in R_2O_3, and have lower $SiO_2:Fe_2O_3$ and $SiO_2:Al_2O_3$ ratios than the parent igneous rocks. The formation of secondary minerals is extremely slow and includes some sericitization, and pelitization of feldspars and the formation of free Fe and Mn oxides. Thermal analysis of the clay fraction in Profiles 86, 84, 45, and 47 did not show the presence of clay minerals.

Our data are in agreement with the morphology and physicochemical properties of soils described in the literature on the first stages of soil formation in the taiga zone of Central Karelia and the Karelian isthmus (9, 14, 15). The primary soils of the taiga zone also contain many stones and a considerable amount of coarse organic matter. They are highly acid and have a very low degree of saturation base. The main secondary minerals are hydromicas, hydrated Fe oxides, and non-crystalline sialic compounds.

The most interesting general feature of the soils we investigated and the primary soils of Karelia and the Karelian isthmus is their richness in R_2O_3 and the decrease in the $SiO_2:R_2O_3$ ratio in an acid or strongly acid environment. The reason for this is that the SiO_2 is more mobile under these conditions than Al_2O_3 and Fe_2O_3. Consequently, some SiO_2 is removed[1] in the tundra, forest tundra, and taiga zones, while there is a relative accumulation of Fe_2O_3 and Al_2O_3. But data directly supporting this (analysis of soil and ground waters) are not available. Hence we adduce indirect data on the behavior of SiO_2 and R_2O_3 in weathering and soil formation (Table 5). When igneous rocks weather under natural conditions, the $SiO_2:R_2O_3$ ratio is lower in weathered fragments than in the fresh rock. This suggests a small, but nevertheless noticeable, removal of SiO_2 (our data on Bol'shoy Lyakhovskiy Island, and the Eastern Sayan; Blanck, Giesecke, and Keese (18) for Northern Norway; Blanck, Riesen, and Mortenson (19) for Spitzbergen; Zemyatchenskiy (8) for the Kola Peninsula, and others).

A decrease in molecular $SiO_2:R_2O_3$ ratios in the residual products was observed also in artificial weathering of and silicate rocks and minerals by the action of water and fulvic acid solutions (17, 12, 1).

The mineralization process of dead plant

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[1] B.B. Polynov wrote about the removal of SiO_2 in the orthoeluvial stage. The Weathering Crust. Izdatel'stvo Akademii Nauk SSSR, 1934.

Table 5

Molecular ratios in various rocks weathered to various stages, in primary soils and mineralized vegetation residues

Place of investigation	Samples	Ignition loss, %	$\frac{SiO_2}{Fe_2O_3}$	$\frac{SiO_2}{Al_2O_3}$	$\frac{SiO_2}{R_2O_3}$	Source
			in % of ignited material			
Spitzbergen Island	Weathered quartzite	0.73	40	12.2	9.6	Blank, Rizer, Mortensen(19)
	Unweathered quartzite	0.03	23	17.4	9.9	
Hindo Island Northern Norway	Soil on granite	6.44	130	10.8	10.6	Blank, Gizenke and Kize (18)
	Strongly weathered granite	1.45	104	11.9	11.7	
	Granite sample from a stream	1.25	125	12.1	12.0	
	Fresh unweathered granite	0.26	122	12.5	12.4	
Kola Peninsula, Murman	Loose crust on surface	Not det'd.			3.8	Zemyatchenskiy (8)
	Fresh plagioclase	"			4.2	
Central Karelia	Ash of Cladonia	9.13[a]	42	6.1	5.4	Ivanova, Koposov, and Shukevich(9)
	Primary soil on granite gneiss	47.13	168	6.4	5.9	
	Granite gneiss	0.48	241	7.2	7.0	
Karelian Isthmus	Ash of Cladonia	1.9[a]	30	11.0	8.5	Rozhnova and Schastnaya (15)
	Primary soil on granite	40.8	34	4.7	4.1	
	Granite	0.4	120	5.7	5.4	
	Ash of living moss	5.4[a]	98	30.3	23.3	
	Lower, mineralized layer of moss	10.7[a]	35	54.1	21.3	
	Ash of sphagnum	4.9[a]	72	16.8	20.0	
	First mineralized layer of sphagnum	7.9[a]	17	6.9	5.0	

[a] Ash content in percent of absolutely dry matter.

residues is similar. These data (13, 15, 4) show that the molecular $SiO_2:Fe_2O_3$ and $SiO_2:Al_2O_3$ ratios decrease gradually during the transition from fresh plant remains to the most mineralized forms. When plant matter decomposes, as in the weathering of rocks, SiO_2 moves more easily than R_2O_3. Thus, the upper horizons of the primary soils, which are rich in organic matter, are relatively enriched in it. In addition, the biogenic accumulation of R_2O_3 and especially of Fe_2O_3 in the ash of mosses and lichens, as well as the fixation of Fe_2O_3 by soil freezing, also play an important role in decreasing the $SiO_2:R_2O_3$ ratio.

The primary soils are products of the foregoing processes, which are closely interconnected. Therefore, the improverishment in SiO_2 and enrichment in R_2O_3 observed in primary soils as compared with the parent material, is caused by processes operating simu taneously: a) weathering of the primary minerals of the rock; b) biogenic accumulation of elements in plants; and c) mineralization dead plant residues.

Thus our data suggest the existence of a wide zone of primary accumulative-lithomorphic soils which are acid, not base-saturated and rich in R_2O_3 and in organic matter, and which are characteristic of the first stages of soil formation in the various subzones of the tundra and in many parts of the taiga zone.

North of this wide zone, under the more severe conditions of the northern Arctic, there are probably zones with different produ of weathering and soil formation on igneous rc

The data of Ivanov (10) (Franz Josef Land

and Blanck (19) (northern Spitzbergen) show that the products of weathering and soil formation on igneous rocks have a neutral reaction, that the adsorbing complex is completely saturated, and that there is no exchangeable hydrogen.

Similar results were obtained by Markov (11) and Glazovskaya (5) in studies of weathering and soil formation on granites and granite gneiss in Antarctica; they noted a great similarity to the most severe regions of the Arctic (Peary Land).

In Antarctica we find typically a desquamational (peeling) ferruginous and carbonate weathering crust with little organic matter and secondary calcium and calcium-phosphate accumulation. The primary minerals are subject to intense physical and chemical disintegration, with chloritization, clay formation, and the formation of crusts and varnishes of varying composition.

A comparison of these data and our data concerning weathering and soil formation on the granites of Bol'shov Lyakhovskiy Island (in the arctic desert zone) show that the processes are fundamentally different. On the one hand, we have neutral or weakly alkaline, carbonate, desquamational products with little organic matter, and on the other, products that are acid, not saturated with bases, rich in organic matter, and loose.

These differences are explained by the different bioclimatic conditions. Though Antarctica receives 400 mm of precipitation annually, most of it is in the solid state, and there is almost no melting, so that the action of water on the weathering and soil formation products is negligible. The amount of solar radiation is high, and hence the relative humidity is rather low (averaging 60%-70%, with an annual minimum 35%-40%). All this results in a negligible amount of leaching. The negligible vegetation, and consequently small biological uptake allow Ca and other elements to separate in the form of carbonate films on the lower surfaces of the rocks.

On Bol'shoy Lyakhovskiy Island the annual precipitation if only 150-160 mm but a large part of it falls in the form of drizzle. The amount of solar radiation is cut by heavy clouds, and the relative humidity is high, fluctuating between 85%-95%. This results in relatively strong leaching of the weathering products.

The scanty data available show important fundamental differences in the nature of the products of weathering and soil formation that occur in the most severe and coldest parts of the northern Arctic and in Antarctica, and those formed in the more southern regions of the southern Arctic and Subarctic. The first may be described as reglaciated cold deserts, with neutral products of weathering and soil formation that are low in organic matter and contain iron and carbonate, and are typical of the most severe and coldest areas of the earth. The second belong to the previously-described zones of acid products, unsaturated with bases and rich in organic matter, which are characteristic of the tundra, forest tundra, and taiga.

The inclusion of the Lyakhovskiy Islands in the extensive zone of Arctic deserts, including all the arctic islands, appears doubtful. The available data warrant their inclusion in the more severe and northern part of the arctic tundra, rather than in the arctic desert zone.

We conclude by noting that the present data show a clear latitudinal zonality of the initial stages of weathering and soil formation and of primary accumulative-lithomorphic soils.

For various reasons, these zones do not always coincide with the soil zones now accepted, as in some cases they are considerably wider.

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DATA ON THE CHARACTERISTICS OF ORGANIC MATTER IN MEADOW-CHESTNUT SOILS IN CONNECTION WITH THEIR CLASSIFATION

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The investigation of meadow-chestnut soils n hollows and depressions has been carried out n the past mainly from the point of view of the genesis of these negative relief elements (1, 10, 2, 18 and others). A number of investigations ave been devoted to the direct study of soils of hollows and depressions (4, 7, 2, 21, and others), but there are no data available in the iterature concerning the organic matter and the composition of humus in meadow-chestnut soils. Kovda (12) assigns soils of depressions to the meadow soils while Sadovnikov (19) assigns the meadow-chestnut soils to the dark soils of depressions of the southern chernozem group. Rode (18) makes a distinction between the dark soils of deep hollows and the meadow-chestnut soils of shallow hollows and microslopes. In he investigations of Ivanova (7, 9), Gerasimov 3), and Ivanova and Fridland (8) meadow-chestnut soils are set apart as a separate group of soils (they were called meadow-chestnut soils or the first time by Ivanova in 1935). However, he foregoing investigations provide no data for classifying these soils according to their organic content and humus composition.

The author collected data in the northeastern part of the Caspian lowlands, in the region beween the Volga and Ural Rivers.

Meadow-chestnut soils occurextensively in zones of chestnut soils with a high surface and subsoil moisture, such as will be found in negaive relief because of drainage from adjacent levations. Under the local conditions of the Caspian depression, these soils are mainly ound in hollows and depressions, and also on undrained plains or "rovnyaks" (former river lood-plain terraces) without surface drainage 8, 13) and a deep water table (the soils are mostly residual-meadow). First, we shall dwell on the group of meadow-chestnut soils, he one most common in the Caspian depression.

Starting with a definition of the group, as deined by the first full session of the Conference n the Nomenclature, Systematics, the Classiication of Soils of the USSR Academy of Sciences, the meadow-chestnut soils must be regarded as a separate group, different from the other soils of this zone. We will draw a comparison between the meadow-chestnut soils and the light-chestnut meadow chernozem and meadow soils on the basis of their respective hydrologic regime, vegetation, content and composition of humus, and fertility.

For this purpose, Profiles 3, 12, and 13 were taken in the chestnut soil zone and Profile 18 in the chernozem zone.

Profile 3. (Early October 1952, wet year). Situated in a hollow 15 cm deep, with a mixed wormwood-grass vegetation (see diagram in Fig. 1), in a dammed-up liman (shallow, seasonally wet depression) of the Atambek region. The meadow-chestnut soils is non-solonetzic, strong solonchak-like. It effervesces from 40 cm downwards. Carbonates precipitated in the form of veinlets from a depth of 89 cm. At 150 cm barely discernible grains of gypsum are found and at 215 cm bitter salt water is found.

A — sod (0-8 cm). A — Humic (8-18 cm). B — transitional, brown with humus intrusions (18-55 cm). B — uniform brown transitional (55-89 cm). C — carbonate (89-140 cm). C — carbonate and gypsum (140-180 cm). C — gleyed layer (180-290 cm).

The sod characteristically is platy in structure and the transitional horizons have a prismatic nut structure.

Profile 12. (End of August 1953; dry year). Situated on a plain, under a wormwood-grass vegetation (see diagram in Fig. 2), near Kamysta Village. The soil is of a light chestnut color, and effervesces from 40 cm downwards. Spots of carbonates are maximum at 58-100 cm, and salt efflorescence is found at 195 cm.

A — humic, porous (0-8 cm). B — transitional, brownish chestnut, prismatic (8-43 cm). C_1 — carbonate, friable (43-56 cm). C_2 — carbonate patches; very compact (56-95 cm). C_3 —

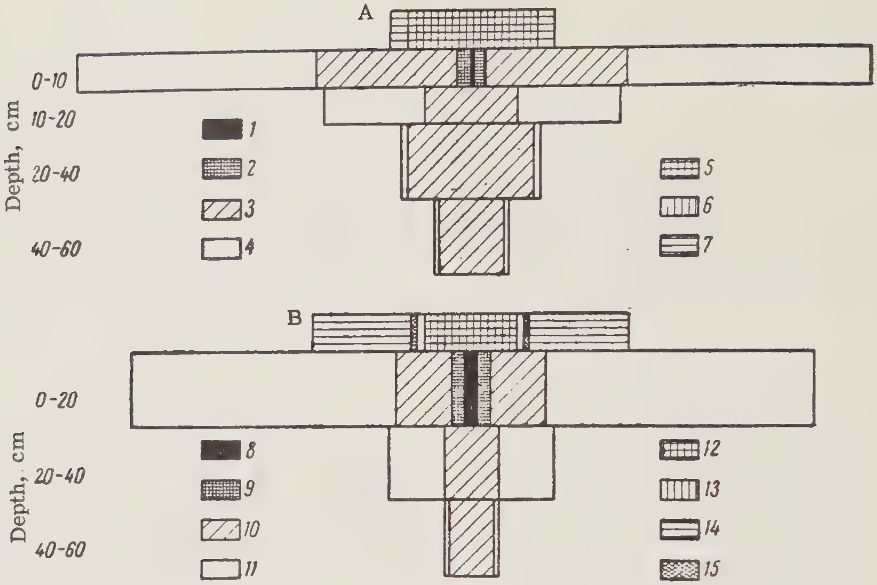

Fig. 1. - Content of surface vegetation and roots (g/m^2)

A - Meadow soil (M), Profile 13. Roots: 1 - >1 mm (of small shrubs); 2 - >1 mm (grasses). 3 - <1 mm (fine); 4 - dead. Vegetation; 5 - grasses (couch-grass); 6 - small shrubs (Austrian wormwood); 7 - litter. B - Meadow-chestnut soil (MC), Profile 3. Roots: 8 - >1 mm (of small shrubs); 9 - >1 mm (grasses); 10 - <1 mm (fine); 11 - dead. Vegetation: 12 - fescue grass, sedge, wheatgrass, feather-grass); 13 - small shrubs (Austrian wormwood, willows); 14 - litter; 15 - mixed herbage (grudnitsa, petrosimoniya).

structureless, friable (95-195 cm). C$_4$ — gypsiferous (195 cm and below). The coloring of the light chestnut soil by humus to a chestnut tinge is less intense and does not penetrate as deeply. The water table is over 20 m deep.

Profile 13. (Mid-October 1952, wet year). Situated in the Sunali Liman under a wormwood-grass vegetation (Fig. 1). The soil is of a meadow type, solodized. Effervescence from 52 cm, and carbonates from 59 cm downward, in the form of small deposits. Soluble salts are not present. Water table at 290 cm.

A$_1$ — 0-4 cm. Humic, blocky. A$_2$ — 4-9 cm. Solodized, platy-blocky. A$_2$/B — 9-24 cm. Solodized, gleyed, nutlike. B$_g$ — 24-39 cm. Transitional, gleyed, prismatic. B/C$_g$ — 39-70 cm. Dark brown, carbonate. C$_g$ — 70-150 cm. Gleyed, carbonate.

Because of solodization, the humus coloring is less intense in meadow soils than in meadow chestnut soils.

Profile 18. (Mid-August 1953, dry year). Situated on a flood-plain terrace of the Talovaya River in syrt areas, among southern chernozems under mixed herb-grass vegetation (Fig. 2). The soil is a meadow-chernozem, effervesces from 50 cm downward. White carbonate spots are abundant in the 90-160 cm layer. No salt efflorescence. At a depth of 200 cm the soil is damp, but not wet.

A — 0-35 cm. Humic, prismatic-blocky; B$_1$ — 35-62 cm. Dark brown, prismatic. B — 62-90 cm. Light straw-yellow, prismatic C$_1$ — 90-160 cm. Carbonate, spotted; C$_2$ — 160-215 cm. Light brown, no spots.

The humus coloring is more intense in comparison with the meadow-chestnut soil. Monoliths were taken from these soils for in vestigation of the root system and the surfac vegetation.

Let us compare the meadow-chestnut soil with the meadow soil. Both develop in negative relief elements, but the meadow soils a more hydromorphic because of more surface water (2).

In the meadow soils, the water table is deeper than in chestnut meadow soils. This probably due to the fact that the chestnut me dow soil profile is situated some 200 km nor of the meadow soil profile. The Sunali Lima is situated in the subzone of the light-chestn soils, while the Atambek is in the subzone o

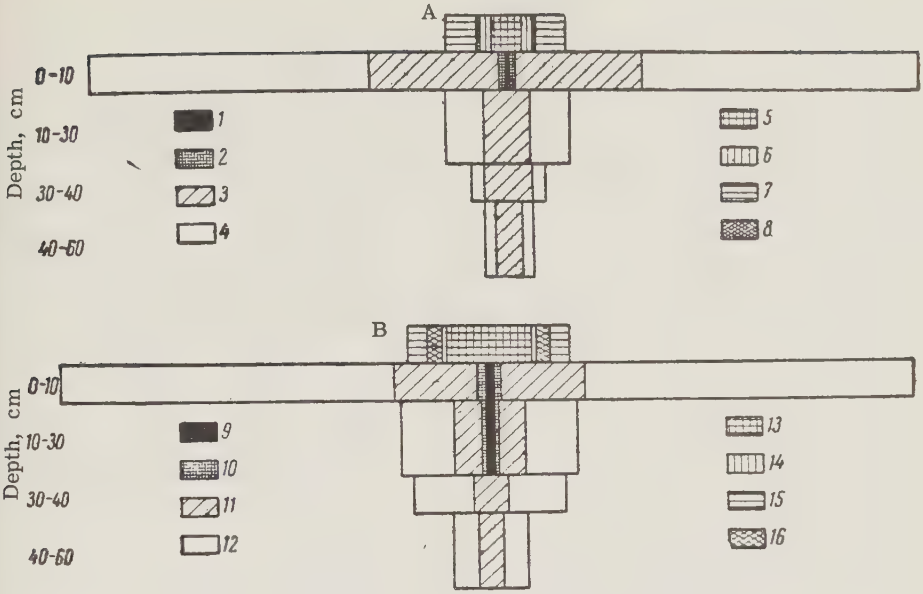

Fig. 2. - Content of surface vegetation and roots (g/m^2)

A - Light chestnut soil (C_1), Profile 12. Roots: 1 - >1 mm (of small shrubs); 2 - > 1 mm (grasses); 3 - < 1 mm (of small herbs); 4 - dead. Vegetation; 5 - grasses (fescue, feather-grass, wheatgrass); 6 - small shrubs (white wormwood); 7 - litter; 8 - mixed herbage (grudnitsa). B - Meadow-chernozem soil (MCh). Profile 18. Roots: 9 ->1 mm (of small shrubs); 10 - > 1 mm (grasses); 11 - <1 mm (of small herbs); 12 - dead. Vegetation: 13 - grasses (fescue, wheatgrass); 14 - small shrubs Austrian and Pontic wormwood); 15 - litter; 16 - mixed herbage (legumes, grudnitsa, yarrow).

hestnut soils, in the liman dam area. More-ver, according to the recent north Caspian ectonic system, Profile 3 is situated in the hizhinskiy embayment, which normally has higher water table, while Profile 13 is situ-ted on the Dzhanybek-Urda uplift, which has a wer water table.

The water table of meadow soils is lower ring autumn perhaps because they have a rger transpiration surface than do meadow estnut soils situated in depressions in solon-z areas.

Meadow soils develop under meadow vege-tion (coutch grass and Austrian wormwood); eadow-chestnut soils are formed under mea-w-steppe vegetation (feather-grass, fescue, eat-grasses, mixed herbs, and shrubs). This fference is connected with the abundant surface ater of meadow soils, which kills off the mea-w-steppe vegetation (15).

The total mass of vegetation — shoot and ot — and the general root distribution is milar in both soil types (Table 1, 2, and 3; g. 1). The considerable surface vegetation ass in the case of meadow-chestnut soils is used by the types of plants, which character-tically produce large shoots (fescue, feather-grass, the wheat-grasses, and shrubs).

Data similar to ours for the underground vegetation mass in the soils of hollows were obtained by Kamenetskaya (11) — 3.39 kg/m^2 for the 0-60 cm layer. Savvinov and Pankova (18a) — 2.0 kg/m^2 for the 0-100 cm layer. In meadow soils Shalyt (22) found 3.4 kg/m^2 for the layer to 100 cm.

Express moisture tends to render the humus of meadow soils mobile, and in this state it is leached from the soil in considerable quantities, especially with solodization (Table 4, Fig. 3). Mobile fractions characteristically predominate in meadow soils: fraction I of the humic acids combined with mobile forms of sesquioxides, and fraction Ia of the fulvic acids (formed as a result of too much water), which are the first to be removed. This is reflected in the diminished humus contents of the meadow soil (Tables 2, 3).

The humus of the meadow-chestnut soil is more resistant to leaching (more "steppe-like"), because the amount of fraction II of the humic acids bound to the calcium of the soil is larger here than in the meadow soil. In the meadow chestnut soil the ratio of humic-acid C to fulvic acid C is 1.56. This shows the marked predominance of humic acids in these soils as com-

Table 1

Amount of air-dry organic matter in the surface vegetation mass

Soil and Profile No.	Grasses	Small shrubs	Mixed herbage	Total	Litter[a]	Total	Approximate amount of C in total bulk kg/m²
13[c]	$\frac{0.345}{3.45}$[b]	$\frac{0.001}{0.01}$	None	$\frac{0.346}{3.46}$	$\frac{0.085}{0.85}$	$\frac{0.431}{4.31}$	0.18
12 K_1[d]	$\frac{0.091}{0.91}$	$\frac{0.049}{0.49}$	$\frac{0.007}{0.07}$	$\frac{0.147}{1.47}$	$\frac{0.169}{1.69}$	$\frac{0.316}{3.16}$	0.13
18[e]	$\frac{0.237}{2.4}$	$\frac{0.016}{0.16}$	$\frac{0.059}{0.59}$	$\frac{0.312}{3.12}$	$\frac{0.114}{1.14}$	$\frac{0.426}{4.26}$	0.18
3 K[f]	$\frac{0.204}{2.04}$	$\frac{0.056}{0.56}$	$\frac{0.019}{0.19}$	$\frac{0.279}{2.79}$	$\frac{0.545}{5.45}$	$\frac{0.824}{8.24}$	0.32

[a] The high amount of litter is associated with autumn sampling of vegetation; it is composed principally of grasses.

[b] The numerator is in kg/m²; the denominator in metric tons per hectare.
Note: C = 42% for vegetation of hollows (according to M. M. Kononova).

[c] Meadow.

[d] Light chestnut.

[e] Meadow chernozem.

[f] Meadow chestnut.

pared with meadow soils, where the ratio of humic-acid C to fulvic-acid C is 1.27 and 0.73.

The ground water influences the meadow soil profile as indicated by solodization and gleization. Advanced solodization results in a reduced adsorption capacity (Fig. 3) for these soils, as compared with meadow-chestnut soils.

We determined the character of the humic acids in these soils by their optical density, using a photometer. Comparison of the optical-density curves (Fig. 4) shows that the meadow-chestnut curve is higher than the meadow-soil curve in almost all parts of the spectrum. This indicates a high optical density for the humic acids in the meadow-chestnut soils, and hence, a higher complexity than in meadow soils. These findings do not contradict the data obtained by Kanonova and Bel'chikova (14).

Areas of meadow soils in the Caspian depression are cultivated as hay fields. Meadow-chestnut soils of hollows and depressions, if present in significant quantities, are plowed, while soil complexes with low amounts of meadow-chestnut soils are used as pasture land.

Let us now consider the differences between meadow-chestnut and light-chestnut soils. The water regime of light-chestnut soils if of a non-leaching nature (zonal soils) and, consequently, their vegetation is of the steppe type — white wormwood and grasses (Fig. 2). The lack of moisture in light-chestnut soils results in a high percentage of carbonates (maximum in the 60-100 cm layer) as compared to meadow-chestnut soils (maximum in the 90-140 cm layer, and less leaching of salts. The air-dry vegetation mass of the two soil groups is approximately the same (that of meadow-chestnut soils is somewhat larger). According to Shalyt (22) the 0-100 cm layer of non-solonetzic chestnut soil contains 2.3 kg/m² of root mass. Our slightly higher figure is apprently due to the fact that the roots were weighed after sieving through a 0.25 mm opening screen. The humus in light-chestnut soils is considerably less than in meadow-chestnut soils. This is explained b the faster rate of mineralization of plant remains, due to the absence of anaerobic conditions. According to Tyurin (20), the humus in the 0-100 cm layer of light-chestnut soil amou to about 10 kg/m², while Kononova (14) found that the humus in the 0-70 cm layer of the soil of depressions amounts to 21.7 kg/m². These figures closely approach our data.

In both soils the first and second humic-acid fractions predominate and the humic acid exceed the fulvic (Table 4), but the molecular structure of the humic acids of the light-chestnut soil, being optically denser, it therefore more complex than its counterpart in meadow-chestnut soil (Fig. 4). Hence the soils differ in the transformation and mobility of humus. The l

Table 2

Content of air-dry mass of roots in humus

Soil and Profile No.	Horizon	Depth, cm	Living roots				Dead roots	Weight of roots in horizon	Total roots in all horizons	Root content		Humus content in soil	
			<1 мм	>1 мм						In each horizon, % of total	% of upper horizon (taken as 100)	By horizons	Total
				Grasses	Small shrubs	Total							
13[c]	A_1+A_2	0—10	0.762	0.062	0.004	0.828	1.291	2.119	4.038[b]/40.38	52	100	4.419	11.071/110.71
	A_2B_1	10—20	0.259	None	0.001	0.260	0.535	0.795		20	38	2.210	
	B_1	20—40	0.686	"	0.004	0.690	0.059	0.749		18	34	3.402	
	B_1C	40—60	0.369	"	None	0.369	0.006	0.375		10	19	1.040	
12 K_1[d]	A	0—10	0.686	0.030	0.013	0.729	1.493[b]	2.222	3.339/33.39	65	100	3.132	10.450/104.50
	B_1	10—30	0.243	0.004	0.003	0.250	0.426	0.676		20	31	3.674	
	B_1+B_2	30—40	0.128	None	0.004	0.132	0.072	0.204		7	11	1.404	
	B_2	40—60	0.123	"	0.004	0.127	0.110	0.237		8	12	2.240	
18[e]	A	0—10	0.453	0.034	0.024	0.512	1.781	2.293	4.068/40.68	56	100	5.372	25.285/252.85
	A	10—30	0.307	0.024	0.050	0.381	0.575	0.956		23	41	9.792	
	$A-B_1$	30—40	0.076	None	0.011	0.087	0.328	0.415		11	20	4.169	
	B_1	40—60	0.131	"	None	0.131	0.273	0.404		10	19	5.952	
3 K[f]	$A+B_1$	0—20	0.619	0.100	0.074	0.793	2.855[b]	3.648	4.836/48.36	76	100	11.440	20.554/205.54
	B_2	20—40	0.282	None	0.002	0.284	0.613	0.897		18	23	5.874	
	B_3	40—60	0.258	"	None	0.258	0.033	0.291		6	9	3.240	

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[a] Numerator, kg/m²; denominator, metric tons per hectare.

[b] Roots were seived through a 0.25-mm opening screen. Sieving the roots through a 0.5 mm opening screen decreased their amount by one fourth (17).

[c] Meadow.

[d] Light chestnut.

[e] Meadow chernozem.

[f] Meadow chestnut.

Table 3

Approximate C content of roots and humus, kg/m²

Soil and Profile No.	Horizon	Depth, cm	C of root mass	C of humus	Soil and Profile No.	Horizon	Depth, cm	C of root mass	C of humus
13 Meadow	A_1+A_2	0—10	0.89	2.56	18 Meadow chernozem	A	0—10	0.96	3.11
	$A_2 \cdot B_1$	10—20	0.33	1.28		A	10–30	0.40	5.70
	B_1	20—40	0.31	1.97		$A+B_1$	30—40	0.17	2.41
	B_1C	40—60	0.16	0.60		B_1	40—60	0.17	3.45
	Total	0—60	1.69	6.41		Total	0—60	1.70	14.67
12 Light chestnut	A_1	0—10	0.93	1.80	3 Meadow chestnut	$A+B_1$	0—20	1.53	6.63
	B_1	10–30	0.28	2.10		B_2	20–40	0.38	3.41
	B_1+B_2	30—40	0.09	0.81		B_3	40—60	0.12	1.87
	B_2	40—60	0.10	1.30		Total	0—60	2.03	11.91
	Total	0–60	1.40	6.01					

Note: C content of root mass was taken as 42% (according to M. M. Kononova); the percent humus = C X 1.724.

Table 4

Chemical and fractional composition of humus in percent of total carbon in soil

Soil and Profile No.	Depth, cm	Total C in soil	Hydrolyzed in 1N H_2SO_4	Soluble in 1N H_2SO_4	Humic acids				Fulvic acids					Insoluble residue	C:N	
					Fractions				Fractions						In insoluble residue	In original soil
					I	II	III	Total	Ia	I	II	III	Total			
13^a	0—4	3.52	9.5	0.5	19.9	7.4	5.9	33.2	3.4	15.8	None	7.0	26.2	30.5	3.7	8.1
	24—39	0.49	19.3	5.7	7.1	1.2	7.9	16.2	9.6	4.7	3.7	4.1	22.1	36.7	4.1	3.7
$12\ K_1{}^b$	0—8	1.16	11.4	3.0	17.5	13.7	0.0	31.2	Not det'd.	9.8	2.4	13.5	28.8	25.6	7.8	7.4
18^c	0—10	4.98	2.9	2.9	4.8	27.4	4.8	37.0	None	19.9	None	4.1	24.0	33.2	9.0	7.2
	20—30	2.45	2.4	5.0	4.3	36.2	3.9	44.4	"	11.6	"	5.7	17.3	30.9	10.8	22.2
$3\ K^d$	0—8	4.56	3.3	4.2	19.9	11.6	6.3	37.8	"	11.1	9.0	4.1	24.2	30.5	6.4	9.0
$19\ C^e$	0—8	1.45	9.4	3.0	13.3	7.1	5.5	25.9	"	17.6	1.5	3.8	22.9	38.8	11.4	5.0

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[a] Meadow. [c] Meadow chernozem. [d] Solonetz.

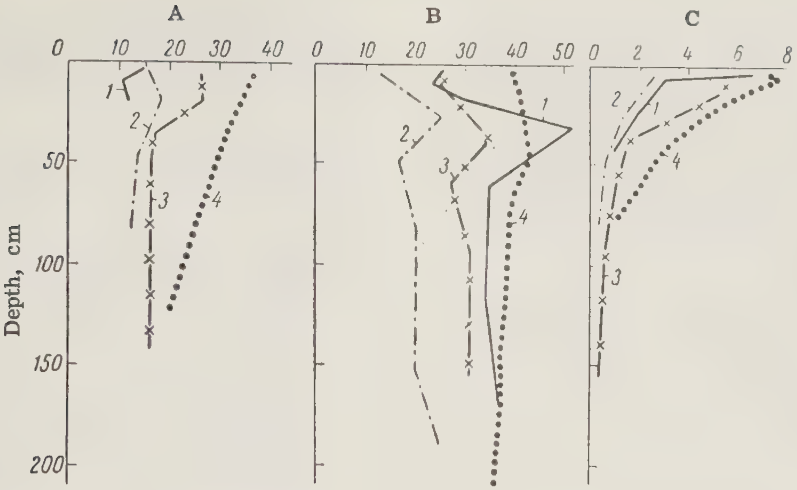

Fig. 3. - Profile distribution curves of: A - adsorption capacity, meq; B - clay fraction <0.001 mm in diameter, %; C - humus, %. 1 - meadow; 2 - light-chestnut; 3 - meadow-chestnut; 4 - meadow-chernozem.

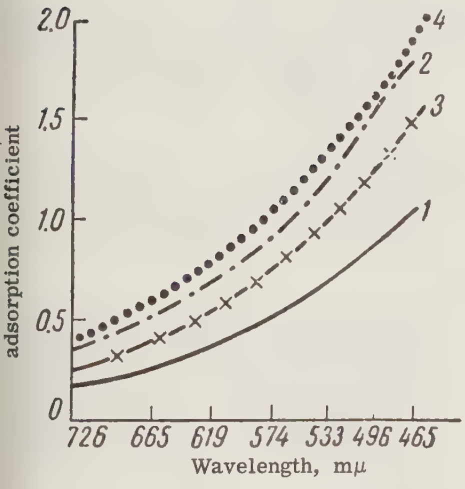

Fig. 4. - Determination of optical density of humic acids by measuring absorption coefficient for humate solutions. Symbols as in Figure 3.

dsorption capacity is related to this low hu- ius content (Fig. 3).

Fields of light-chestnut soils are used for asture or as cultivation deficient in precipi- ation.

Let us mention a few features in which mea- ow-chestnut soils differ from meadow cherno- ems.

Meadow chernozems are analogs of meadow-chestnut soils in the chernozem zone, and resemble them from the point of view of salt and water regimes. Both support mixed herbaceous-grass vegetation, though the mixed herbage is somewhat richer and more luxuriant on meadow chernozems. The total mass of vegetation in both soils is similar (Tables 1 and 2; Fig. 2). The temperature and moisture conditions in meadow chernozems favor more rapid decomposition of organic matter with the accumulation of humus. Humus is more uniformly distributed in the chernozem profile owing to a more uniform distribution of the root system. While calcium-bound humic acids (fraction II) predominate in the chernozems, fractions I and II are almost equal in meadow-chestnut soils. In both soils the ratio of humic-acid C to fulvic-acid C is high (Table 4). Since the soil is derived from solonetz, the humic acids in meadow-chestnut soils may be bound not only to sesquioxides, but also to magnesium and sodium (13). Fraction I also predominates in solonetz (Profile 19; see Table 4). It appears to consist of soluble humates of Na and Mg and is characteristic for solonetz (13).

The adsorption capacity of meadow chestnut soil is greatly increased by the prevalence of Ca-bound humic acids (Fig. 3).

The weaker migration in meadow-chestnut soil is evidenced not only in the fractional composition of the humus (predominance of fraction II), but also in the slight change in the clay fraction across the profile (Fig. 3). The humic acids of meadow-chernozem are of a more complex structure than those of meadow-chestnut soils (Fig. 4).

Conclusions

The organic material and humic composition of meadow chestnut soils are described.

These soils are distinguished from genetically related groups by their vegetation, their humus content, the specific nature of their humus, the nature of the breakdown and movement of materials along the profile, and by their water regime.

Complex areas which have a high percentage of meadow-chestnut soils are recommended for field crops, and those with a low percentage, as pasture land.

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EFFECT OF MOLE DRAINS ON THE FERTILITY OF CHERNOZEM AND CHESTNUT SOILS

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The use of mole drains in saturated soils to improve crop yield is a technique known in the USSR for over 20 years; it has been practiced in the last few years (2, 3, 5, 6).

We studied the use of artificial mole drains in areas of irregular and inadequate moisture. Very thorough investigations were made in Kursk Region on clay loam typical chernozems; investigations were also made on the fine clay loam Ciscaucasian chernozems in Rostov Region, on clay loam chestnut soils in Saratov Region, on clay loam dark chestnut soils in the Crimean Region, and on sandy loam and clay loam sod-podzolic soils in Moscow Region.

Nine field experiments conducted by us at the Kursk Zonal Reclamation Experimental Station, and more than twenty subsequent experiments made by the station staff, have led to the conclusion that the presence of mole drains at a depth of 40 cm and 70-105 cm apart increases the yields of grain crops by an average of 5%-10% and of root crops by 10%-20%.

Experiments carried out in 1957 at L'gov Zonal Selection Experiment Station not only confirmed these conclusions, but also showed that the use of mole drains under the conditions prevailing in Kursk Region was more effective than any other new agronomic measure in increasing the yield of sugar beets (Table 1).

Associated observations at the Kursk Zonal Reclamation Experiment Station revealed the following:

a) In the overwhelming majority of cases, on plots containing mole drains, soil moisture was higher in the vicinity of the mole drains (the average additional moisture was 100 m^3/ha). During the dry seasons in 1950-1956 moisture decrease in the walls of the mole drains was recorded four times.

During warm seasons, relative drying also occurred in the soil under the mole drains. In these places the soil moisture was 1%-2% lowe than between drains in the same horizon or in plots with no drains. This is probably due to the compacted bottom of the mole drains, whic impedes the passage of water vapor along the temperature gradient from the upper to the lower horizons.

b) Mole drains activate microbiological processes. This is especially noticeable at the end of May and at the beginning of June under the plow layer, when the number of microorga isms is doubled. The mole drains have a special influence on azotobacters (Table 2) and certain other aerobic microorganisms. Towards autumn, the differences in microbiological activity in soils with and without mole drai tend to disappear.

Activation of microbiological processes in soils containing mole drains is probably due primarily to the additional aeration. In autum the negative influence of the accelerated coolin of the soil (described below) is superimposed on this effect. Under the conditions of Kursk Region, the improvement of the water regime of plots with mole drains is insignificant: mos experiments showed that during the growing season of agricultural crops the soil moisture contents were larger by 50-150 m^3/ha than in plots without mole drains.

c) Different microbiologic activities in soil according to the presence or absence of mole drains, give rise (with certain delays) to differences in the nutrient regime. The contents of available nitrogen and phosphorus are highe in plots with mole drains (Table 3), but decrea towards autumn, and sometimes the contents o available compounds of these elements are lower in soils with mole drains than in soils without them. The average addition is 5-10 kg/ha

d) Artificial mole drains stimulate the development of the root system of crops. In ou experiments, the root system of buckwheat below the plow layer increased by 30% (1949), an

Table 1

Effect of method of tillage on the yield of sugar-beets

Method of plowing	Yield of sugar beet in cntr/ha					
	On plots				Average	In % of control
	1	2	3	4		
With moldboard, to 20 cm Control	366	346	288	252	319	100
With moldboard, to 30 cm	373	373	344	334	362	113
Two-layer plowing to 40 cm with overturn of horizons	323	(393)	347	357	355	111
Without moldboard, to 40 cm	305	362	350	284	325	101
With moldboard to 25 cm+soil-deepening by 15 cm, with 30 cm interval	353	(411)	378	355	374	114
With moldboard to 25 cm+mole drains at 18 cm, with 105 cm interval	379	387	—	—	383	120

Table 2

Effect of mole drains on the development of azotobacter. Average number of colonies in a Petri dish, for the upper 60 cm of soil[a]

Methods of tillage	Dates of observation				
	April 17	May 14	June 24	July 2	Aug. 11
Without mole drains	59	141	204	193	722
With mole drains	507	267	193	216	804

[a] The experiments were made in collaboration with Ye. P. Gromyko. The mole drains were dug the previous autumn.

at of winter wheat (1951) by 16%. On plots with
ole drains it was found that the number of roots
spring wheat crops increased by 108%, and the
tive absorbing area increased still more.[1]

Further investigation in 1957 by the staff of
e Kursk Zonal Reclamation Experiment Station
owed that mole drains stimulated root develop-
ent of all crops studied (Table 4).

e) The rate of water consumption was lower
plots with mole drains than otherwise: by 20%
r spring wheat, by 15% for winter wheat, by 9%
r sugar beets, by 29% for potatoes, etc. Be-
des, more effective utilization of natural pre-
pitation in soils with mole drains and of soil
oisture was improved. This was shown to re-
lt primarily from the quicker and greater ex-
nsion of the root systems of plants into the profile and also from the prevalence in the soil of more favorable conditions for condensation.

Experiments[2] showed that in plots with mole drains, spring wheat in the tubular stage had about twice (208%) as many roots below the plow layer and the active absorbing area was five times or more larger than in areas without mole drains. A deep root system, developed in the early stages of growth, ensures the plant with moisture in the deep horizons. It is known that in forest-steppe zones, at the beginning of the growing season, there is plenty of moisture below the plow layer, while the upper layer is very dry.

Lavish development of a root system with many rootlets having a high turgor shows that they absorb water vapor and oxygen from the air

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[1] These experiments were made with the collabora-
n of I. A. Volkov, N. S. Petinov, and N. F. Peshek-
nova.

[2] Carried out with the collaboration of I. S. Volkov, N. S. Petinov, and N. F. Peshekhonova.

Table 3

Effect of mole drains on the nutrient content in top 60 cm of soil
(in mg/kg of dry soil)

Crop, year	Date	Nitrate nitrogen		Available phosphorus		Observer
		Without burrow-filling	With burrow-filling	Without burrow-filling	With burrow-filling	
Winter wheat, 1951	July 2	2.5	3.0	34.5	39.1	V.I. Bobchenko
Table beets, 1954	May 12	7.3	10.0	9.5	11.5	S.M. Chupry nina
	July 18	3.3	7.2	7.4	12.6	
	Aug. 3	1.3	2.0	7.9	14.0	
Potatoes, 1954	June 22	17.9	19.9	6.1	7.6	M.S. Zhuko
	Aug. 26	3.0	5.1	19.3	24.5	
	Sept. 21	6.4	2.4	9.6	7.0	
Sugar beets, 1957	Apr. 23	5.7	9.1	19.9	18.9	I. Kh. Besko
	May 22	23.5	25.1	—	—	
	June 24	13.2	13.3	22.6	25.0	
	July 24	4.4	12.3	18.1	25.5	
	Sept. 11	1.0	0.9	16.8	17.3	
Potatoes, 1957	June 10	11.4	14.6	21.0	31.6	I. Kh. Besko
	July 12	6.5	10.2	18.4	34.3	
	Aug. 7	0.7	1.7	17.5	24.3	

present in the mole drains.

f) Two years of observations on the influence of mole drains on soil temperature showed the following: the soil around the mole drains is cooled more rapidly in the autumn. This is not only caused by the low temperature of the air, but also by the consequent drying of the drain walls. When there is a sharp drop in temperature, the relative cooling of the mole-drain walls reaches 3°-5° C.

In the summer the mole-drain wall temperature fluctuates within 2° C. In early spring the plow layer above the mole drain is observed to be 1°-4° C warmer, and below the plow layer the temperature is 2°-3° C lower. In May the soil in the mole-drain walls warms more rapidly than the soil beyond them. These temperature deviations are merely tendencies, and are obliterated by sharp changes of the weather.

Thus, the temperature of the mole-drain walls may vary in either direction from the temperature of soil in the same horizon. Usually this does not exceed 1°-2° C, but may change several times in 24 hours.

The horizontal temperature gradients, in the presence of the saturated soil atmosphere in the horizon with mole drains, favors condensation and increased availability of soil moisture for plants.

Mole drains aid circulation of air in the
This is mainly due to the presence of the ho
mole drains with the radially fissured soil a
them (usually formed when the mole-drain i
dug) the secondary temperature gradients s
plement this. Direct observation of the def
tion of smoke from smoldering points showe
circulation of air along mole drains located
steep slopes (0.01-0.05). The direction of
movement depends on the temperature of th
air in the mole drain and of the atmospheri
er near the ground. In the warm periods o
day, when the soil becomes dry, an ascendi
current of air appears over the mole drains
the warm air rises and is replaced by air f
the drains, which in turn has entered throu
the open ends.

Air movement in a mole drain may be a
panied either by drying of the soil or by co
sation of water vapor from the atmosphere
periments showed that the direction of the
cess depends on the temperature of the soil
the drains and the dew point of the atmosph
near the soil. In the forest-steppe zone, e
cially in Kursk Region, condensation proce
predominate; 1 m³ of air moving through a
drain may cause the condensation of up to
water.

In the steppe zone, drying processes pr
inate, inasmuch as the dew point is almost
ways lower than the temperature in the dra

Table 4

Effect of mole drains on the development of root system of crops, under the conditions of Kursk Region

Crop	Date of observation	Horizon, cm	Number of roots in 25 X 25-cm plots: Control, without mole drains	In area with mole drains	Between mole drains	In areas with mole drains, % of control	Remarks
Sugar beets	June 28	0–20	362	429	416	118	
		20—40	207	358	311	173	
		40–60	183	286	260	142	
Potatoes	June 26	0—20	474	556	447	117	
		20—40	293	382	338	130	
			230	317	266	138	
Maize	Aug. 10	0—20	352	452	Not det'd.	126	
		20 - 40	223	283		127	
		40—60	233	272		117	
Alfalfa mixed with timothy	May 16	0—20	20.2	26.1	24.5	129	Reduced to one plant
		20—40	12.1	16.1	14.8	133	
		40—60	8.9	9.0	8.5	101	
Oats mixed with vetch	June 7	0—20	5.6	6.5	6.7	125	"
		20—40	6.6	9.4	9.7	142	
		40—60	7.7	11.6	9.4	151	
Barley	July 2	0—20	21.3	20.5	19.6	96	"
		20—40	15.9	22.9	18.8	144	
		40—60	14.6	15.7	17.5	108	

his process is much enhanced when the arch of ie drain cracks because of shrinkage of the ried soil.

Because of their drying effect, mole drains o not, as a rule, increase the yield of agricul-ural crops in the steppe zone. Somewhat lower ields were observed on plots with mole drains i the steppe zone at the Engel's Reclamation xperiment Station, the Zaporozh'ye Sprinkling rigation Experiment Station, and also under etter conditions in Rostov Region. However, xperiments (1, 6) showed that in moist soils of is zone (irrigated areas, with a high water ible, etc.) mole drains increase the yield of gricultural crops, and their installation is an conomically profitable agronomical measure.

Mole drains can advantageously be used for ubsoil irrigation in the steppe zone, where iere is usually insufficient moisture. This is ie most advantageous irrigation process for the rops of the field-crop rotation (1).

In the forest-steppe zone the positive effect of iole drains on the soils and vegetation is so reat that they are used for all crops, and especially for row crops (potatoes, sugar beets, corn, and others). Installation of mole drains simultaneously with plowing costs less than 20 rubles/ha, and separately, approximately 50 rubles/ha. The net income from the sale of the additional crops, according to the official prices, is 2000 rubles/ha for potatoes, 500 rubles/ha for sugar beets, and 100 rubles/ha for grain.

No less important is the use of mole drains for irrigation in the forest-steppe zone. The drains are dug with every autumn plowing, and sometimes after plowing. The presence of mole drains greatly increases crop returns during humid and moderately humid years.

In dry years, occurring here once every three to five years, temporary channels 50-120 m apart are dug across the mole drains. Portable pumps supply water to these channels through pipes constructed according to Z. M. Metel'skiy. This water spreads through the mole drains, thus wetting the soil. In clay loams the upper meter of soil is uniformly moistened and the plow layer does not get too wet. (1, 4). The additional expenses per flooding with this method is 75-200 rubles/ha. In dry years the increase in crop yield after one or two irrigations exceeds the expenses for irrigation, even with grain crops.

Experiments with subsoil mole-drain irrigation carried out in Kursk, Rostov, and Crimean Regions have shown that here the stability of mole drains is satisfactory. The following conditions must be fulfilled to obtain stable mole drains:

a) there should be no loosening of the soil, even partial, when the drains are dug; b) the drains should be dug in the autumn, and water irrigated through them only the following year. The long wet interval between the installation of the mole drains and the first irrigation through them allows slow cementation of the soil particles in the wall of the drain. This increases the strength of mole drains in chernozem by a factor of two or three; c) the walls of the drains should not be allowed to dry before irrigation to less than the maximum molecular moisture capacity. It is desirable that the soil moisture in the horizons containing the drains should not fall below 80% of the field moisture capacity. If the soil is drier than this, the water-stability soil wall drains to irrigation decreases considerably.

Experiments in chernozems and structural dark-chestnut soils showed that, when these conditions were fulfilled, the drains could withstand two to five irrigations. This amount of water suffices for a successful yield of the rotated field crops in these zones. In alluvial chestnut soils and in sandy loam podzolized soils, only one large quantity of irrigation could be accomplished.

The most urgent problem for laboratory and field study is to determine what soil conditions produce stable mole drains. The resistance of models in water was tested in the laboratory. The models were prepared under a pressure of 50 kg/cm^{3}at a moisture content equal to, or somewhat higher than, the lower plastic limit (according to Atterberg). The laboratory-field method consists of testing short sections of mole drains by irrigating with a given amount of water and subsequent measurement of the degree of collapse.

The Experiments in Rostov and Moscow Regions and at the Kursk Zonal Reclamation Experiment Station showed that subsoil irrigation in mole drains is very promising for field crops, even in areas of high yields.

In some cases it was possible to combine irrigation with accumulation of surface runoff in the drains. The water of spring runoff and heavy rains is trapped in the temporary canals or in simple ditches and from there it may be distributed through the mole drains.

This method of subsurface irrigation can be successfully applied to various crops using ru off water, in part from residential and industr al-residential areas.[3] Thus, for example, ir rigating mole drains with waste water from th Kupavina light textiles factory provides compl utilization in agriculture of mineral nutrients found in them as well as the moisture, while maintaining sanitary conditions in the fields. This is also one of the best and cheapest avail able methods for purification of waste water.

The presence of stable mole drains below t plow layer supplies liquid and gaseous (ammo and others) fertilizers to the soil, permits co trol of aeration by supplying air through them from distribution pipes with hoses, and also permits the heating of soils with heat from loc industries and other sources.

Conclusions

1. Artificial mole drains can be used for su surface irrigation, accumulation of water, dra age, aeration, and as an agronomical measur for influencing the water, air, heat, and nutri regimes of the soil.

2. In the forest-steppe zone, annual diggin of mole drains below the plow layer increases the yield of agricultural crops by 5%-20%, an from the economic point of view it is a very e fective agronomical measure.

3. Mole drains may be successfully used f subsurface irrigation in dry years, which occ in the forest-steppe zone once every few year

4. The beneficial effects of mole drains on the soil combined with periodic subsurface ir gation constitute appropriate means for impro ing even on high yielding areas in the forest-steppe zone.

5. Since mole drains usually have a drying effect on soils in the steppe-zone, they shoul be applied only when there is ample moisture present (flood plains, bog soils, in irrigated areas, in places with artificially increased moisture contents, etc.).

6. The feasibility of using mole drains for subsurface irrigation depends on the stability and resistance of the soil to water, and also the method of digging and use of the drains. Methods for determining whether soils are suita for digging stable mole drains are mentioned in paper.

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[3] The experiment was done in the All-Union Scie fic Research Institute of Hydraulic Engineering and Reclamation with the collaboration of the Ivashevsk Forestry Reclamation Station and Kutuzov kolkoz i Noginskiy District, Moscow Region.

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NEW CONTRIBUTIONS TO WIND SOIL EROSION AND ITS CONTROL

(II. Effect of Nature and Properties of Soil Surface Upon Wind-caused Erosion)[1]

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Dokuchayev (1), Vysotskiy (2), Vil'yams (3) and others noted that great influence is exerted on wind soil erosion by morphology of the earth's surface, promoting increased or decreased soil blowing in individual relief elements. Vysotskiy (2) stressed that all elevations' windward slopes are buffeted more by air streams when the slopes' direction is closer to the wind's perpendicular direction, when declivity is more abrupt and differs more sharply from general relief.

Irregular relief affords a protective effect, especially on elevations' leeward side; this effect increases with steepness of slope. Where relief is smooth, lines of equal wind speeds correspond to slightest changes.

Research shows that the nature and degree of soil surface unevenness have great affect on wind velocity in the near-ground layer. Intensity in wind woil erosion depends mainly on wind velocity up to the point of a jump-like movement of soil mass, i. e., to 30 cm and somewhat more (17). Hence any measures to reduce surface wind velocity and to check moving aggregates and particles are finally directed to reducing and avoiding wind soil erosion. To protect soil against wind erosion, methods such as ridging fields and mulching soils with stubble residue are applied. In either case, wind velocity at the soil surface decreases noticeably, especially when both methods are combined (10). Figure 1 shows wind velocity at a maximum over even soil with exposed surface (curve 1) and at a minimum over ridged soil covered with straw (curve 4); amount of blown soil mass is obviously a direct function of wind velocity. Mean wind velocity over a smooth surface with straw worked into the soil (curve 2) was higher than over a ridged surface (curve 3); in the latter case, blown soil mass was greater. Mulchin
with stubble residue (stubble, straw) is more
effective than ridging for reducing wind soil erosion. This is caused not only by reduced wind velocity but also by greater ability of stu
ble residue to retain the soil mass.

Importance of Cloddy Structure for Protecting Soil from Wind Erosion

Wind has two effects on soil: first, tears
and displaces free soil particles; second, impact of the moving particles breaks up clods
large aggregates, thereby increasing the ero
soil mass.

Soils with a good water-stable structure a
often subjected to severe wind erosion (the ag
gregates are too fine to resist the wind). If s
contains > 50%-60% of aggregates > 0.84 mm
diameter (being determined by dry sieve met
such a soil is but slightly subjected to wind e
sion apart from the aggregates' water stabilit
(12). Hence in cultivated soils, the larger nonerodible fractions shield the blowing of erosion particles and possibly of the soil as an entity.

Wind-tunnel tests on soils of various textu
(6, 7) showed that soil erodibility, q, (in kg
on a smooth surface at wind velocity up to 11
m/sec at 30 cm height can be found from the formula:

$$q = \text{antilog}\left[\frac{0.75C + 1.14D + 1.49E + 1.80F}{C + D + E + F}\right.$$

$$\left. 0.5\,\frac{B}{A + B} - 0.042(D + C + E + F),\right]$$

where in percentages: A = erodible fraction
<0.42 mm in diameter; B = erodible fraction
from 0.42—0.83 mm in diameter; C = nonero
fraction, 0.83—2.0 mm in diameter; D = nonerodible fraction, 2.0—6.4 mm in diameter;
= nonerodible fraction, 6.6—12.7 mm in diameter; and F = nonerodible fraction, >12.7 m

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[1] Cf. Zh. Pochvovedeniye, No. 7, 1959.

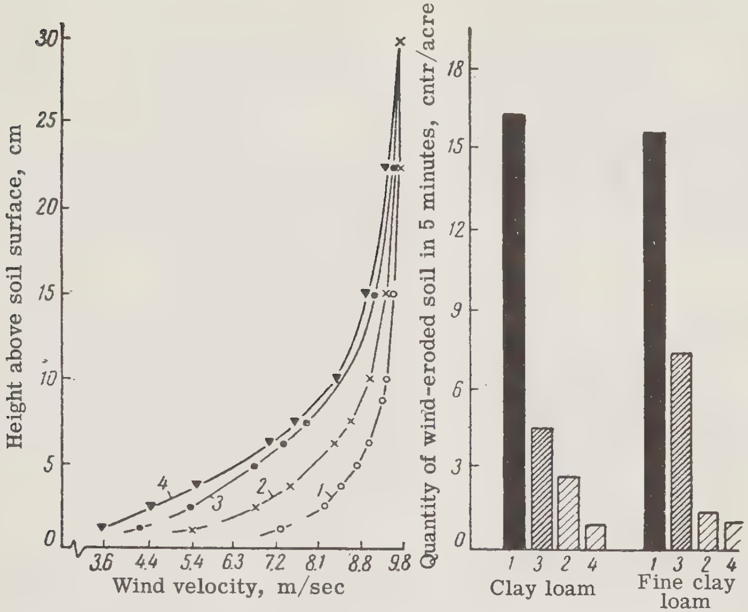

Fig. 1. - Wind velocities at various heights above the soil surface and quantity of wind-eroded soil mass.

1 - smooth, eroded surface; 2 - the same as 1, but with wheat straw worked into the surface from an estimate of 1.25 metric tons/ha; 3 - ridging, at 180° to the wind, surface with ridge heights 3.1 cm and width 17.5 cm; 4 - the same as 3, but with worked-in straw as in 2 (Chepil).

diameter.

To establish soil erodibility according to the ndicated formula, soil must be sieved in an air-ry state, the percentages of separates falling ithin various size ranges must be determined. ccuracy of analyses and results is attained by sing a rotary sieve (8). Tables are compiled facilitate calculations.

For greatly erodible soils, $q>1$, while for hose of average erodibility, $q<1$. Those with <0.1 are strongly resistant to wind erosion.

The B fraction (about 0.5-1 mm in diameter) s less subject to wind erosion than is the A raction. Maximum protection of fractions A nd B is achieved by the nonerodible fractions -6 mm in diameter and larger, which are not noved even at exceptionally strong winds (6). oil blowing may be stopped by any size of nonrodible fractions, if present in sufficient quantity. If fraction A, mixed with any amount of onerodible fractions, is replaced by fraction , wind soil erosion will decrease 75%. To liminate wind soil erosion fully, not less than alf the soil by weight should be nonerodible ractions (as C and D) or be comprised of 2/3 oarse clods.

The foregoing formula applies only to an approximation of soils' erodibility and is best for homogeneous and newly tilled soil, rather than for that which has lain fallow or is encrusted. The soil's structure and hence its susceptibility to erosion varies from year to year, season to season, and even within shorter periods (depending on weather, types of cultivation, etc.). Thus results of determining soils' erodibility according to the formula are of relative significance only for the given period and given soils (6, 7, 9, 11, 13, 15, 16).

The soil-protecting effects of the aggregates, clods and ridging are not always reliable. In coarse soils, especially sandy loam, the clods soon disintegrate (4, 5, 18). Even with tilling, one is unable to develop a reliable wind-resistant surface. Under variable weather conditions, in clayey soils the clods break into fine aggregates which erode readily. Mechanical stability of clods is also typical for carbonate soils. The most stable clods are formed in clay loam, although erosion may redeposit them or remove their protective effect. Hence these soils can be reliably protected only if tilling to develop a cloddy surface is coupled with other methods such as mulching with harvest residue.

Soil Properties Affecting Wind Erosion

Wind soil erosion is influenced by cloddiness and many other variables including the following: 1) relative quantity of water-stable aggregates with diameter >0.5 mm; 2) relative quantity of water-stable aggregates with diameter <0.05 mm and in particular <0.02 mm; 3) texture; 4) carbonate contents and 5) amount and type of organic substance.

Effect of Water-stable Aggregates on Wind Soil Erosion

Laboratory (wind tunnel) and field studies have shown that soils exposed to wind erosion contain many water-stable aggregates 0.05-0.5 mm in diameter, while soils resisting blowing have many aggregates >0.5 mm diameter, as well as many water-stable aggregates and particles <0.05 mm diameter, especially those <0.02 mm in diameter (9-13). Table 1 portrays pertinent analytical data on samples of important soils from Manitoba, Saskatchewan and Alberta taken from depths up to 10 cm.

Clays, sandy loams and clay loams are similar, differing only in structure, especially in content of the fraction >0.42 mm in diameter. Table 1 shows that at an increase in nonerodible and difficulty-erodible water-stable aggregates >0.42 mm diameter, soil cloddiness increases while its erodibility decreases. When content of water-stable aggregates 0.42-0.83 mm in diameter increases from 0% to 12.1%, erodible soil decreases by more than twice. A doubling of amount of this fraction greatly reduces the amount of eroded soil, while tripling causes a trivial reduction. Such a regularity occurs in most tested soils but in various ways. Data in Table 1 show that the larger the water-stable aggregates, the more the cloddiness increases and the more soil erodibility decreases. A survey of data for the two penultimate samples makes this obvious. By comparing them, we see that at content of 8.6% of aggregates 0.83-2 mm in diameter, cloddiness has increased much more sharply than for the case of an almost doubled amount (15.2%) of finer (0.42-0.83) aggregates. Evidently the content of 15.2% of fine aggregates proved less effective for decreasing soil erodibility than did almost half this quantity (8.6%) of coarser aggregates. Similar comparisons can be made with other data in Table 1.

Data in Table 2 show that together with increased water-stable aggregates <0.05 mm in diameter and especially <0.02 mm diameter, cloddiness increases correspondingly and hence soil erodibility decreases. Although water-stable aggregates 0.02-0.05 mm in diameter also increase soil cloddiness and decrease erodibility, their effect is insignificant compared to the part which is <0.02 mm in diameter.

Effect of Texture on Wind Soil Erosion

The soil's texture greatly influences wind erosion. Two basic types of wind erosion are noted: 1) mass and 2) selective.

Massive blowing occurs in soils having a u form fine texture. In this case, wind erosion causes a slight sorting of the particles, since most mechanical elements are subjected to blowing (e.g., soils formed on loess and loes like parent materials).

Selective wind erosion occurs in soils with coarse texture. Wind erosion involves a sorti of particles and a removal of fine earths, whi the large particles remain in place or are bor far from the foci of erosion. These coarse particles form hummocks and dunes; in certai cases, a unique type of crust (a wind alluvium is developed.

Soils of coarse and fine texture are more s ceptible to wind soil erosion than are those of medium texture. Exposure of coarsely graine soils to wind erosion is caused by their weak coherence which prevents clod development. resistance of coarse sandy particles to blowin is usually higher than fine sandy particles. I fine-textured soils with many clay particles (a result of wetting and drying, freezing and thawing) the clods easily break into aggregate which are too fine and are incapable of resisti wind erosion (12, 13). In soils of medium tex ture, content of silt and clay particles is enou to increase their cohesion but insufficient to cause the clods to break down excessively or form fine aggregates. In improper cultivatio even these soils (as a result of pulverization) can be subjected to severe wind erosion (13). Diameter of individual soil particles also influences wind erosion.

As Table 3 shows, the velocity threshold quired for continuous movement is the least f sandy particles 0.1-0.5 mm in diameter; for smaller particles, the threshold increases as their size decreases. Owing to adhesion and mainly to a viscous surface air layer, free s particles (0.005-0.01 mm diameter) greatly sist wind erosion and are not moved even at wind of 16.5 m/sec at 15 cm height. Usually particles <0.005 mm in diameter are not present since they occur mainly in aggregate state. Having high resistance to wind erosio individual particles <0.02 mm in diameter d not have disruptive force; when wind-blown, they adhere to clods and other obstacles.

Wind-tunnel tests showed that exposure of soil blocks to breakdown by sand particles an the formation of fine soil particles exposed t wind erosion depend directly on adhesion for (Table 4).

The high cohesive strength of dry clay an

Table 1

Relation of composition of water-stable aggregates (with diameter >0.42 mm), structural spil, and wind erosion (9)[a]

Soil	Moisture equiv.	Organic matter	Water-stable aggregates, %							Structural composition, %							Amt. of wind-eroded soil in 18 min., t/acre
	In %		>2.0 мм	2.0—0.83	0.83—0.42	0.42—0.25	0.25—0.05	0.05—0.02	<0.02 мм	>38.0 мм	38.0—12.7	12.7—6.4	6.4—2.0	2.0—0.83	0.83—0.42	<0.42 мм	
Clay	38.2	2.09	0.0	0.0	0.0	29.2	52.8	13.5	4.5	0.0	3.0	3.0	1.1	0.2	3.2	89.5	41.75
	37.9	2.11	0.0	0.0	12.1	31.0	39.4	12.9	4.6	0.0	1.5	3.7	4.2	4.2	22.9	63.5	16.90
	38.4	2.09	0.0	0.7	23.4	31.6	26.7	13.1	4.5	0.0	3.2	3.0	7.2	10.5	19.2	56.9	4.36
	37.5	2.10	0.0	1.3	36.6	23.9	20.0	13.7	4.5	0.0	11.9	5.4	13.2	19.7	29.7	20.1	1.04
	36.1	2.12	0.0	25.6	28.4	16.3	11.9	13.2	4.6	5.4	6.0	1.6	6.6	58.5	11.9	10.0	—0.24[b]
Loam	21.0	1.11	0.0	0.0	0.7	18.3	61.7	15.2	4.1	0.0	2.0	11.6	3.2	3.9	13.2	66.1	10.15
	20.3	1.13	0.0	1.0	16.5	25.8	37.4	14.7	4.6	0.0	2.9	9.8	4.1	5.1	21.0	57.1	7.83
	20.5	1.11	0.0	2.1	31.3	20.5	27.4	14.6	4.0	0.0	6.0	10.8	3.9	4.1	27.0	48.2	6.09
	19.7	1.12	0.0	7.3	37.8	17.6	17.7	15.2	4.4	0.0	2.7	9.1	7.9	15.4	21.8	43.1	1.33
Fine sandy loam	9.7	1.10	0.0	0.0	0.0	3.9	89.6	5.5	1.0	0.0	0.0	0.0	0.0	0.3	1.6	98.1	107.00
	8.9	1.10	0.0	0.0	8.5	4.9	80.6	5.0	1.0	0.0	0.0	0.0	0.0	0.8	12.5	86.7	105.30
	8.4	1.10	0.0	0.0	14.2	5.7	73.0	5.0	1.1	0.0	0.0	0.0	0.0	0.4	20.5	79.1	81.01
	8.8	1.09	0.0	8.6	1.5	3.5	80.2	5.2	1.0	0.0	0.0	4.0	0.0	6.9	17.6	71.5	31.39
	7.7	1.09	0.0	6.2	14.6	5.4	68.2	4.5	1.1	0.0	0.0	3.9	0.2	10.4	2.0	83.5	23.21

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[a] Samples taken from 10 cm depth from soil surface.

[b] Minus sign signifies that accumulation predominates over loss to wind erosion.

Table 2

Relation of water-stable aggregates (with diameter <0.05 mm), structural soil, and its wind erosion (9)

Soil	Moisture equiv.	Organic matter	Water-stable aggregates, %							Structural composition, %							Amt. of wind-eroded soil in 18 min., t/acre
			<2.0 мм	2.0–0.83	0.83–0.42	0.42–0.25	0.25–0.05	0.05–0.02	<0.02 мм	>38.0 мм	38.0–12.7	12.7–6.4	6.4–2.0	2.0–0.83	0.83–0.42	<0.42 мм	
Clay	40.1	2.50	0.0	1.2	21.4	28.1	31.7	10.0	7.6	0.0	0.0	1.3	4.9	6.6	35.8	51.4	18.98
	37.0	2.48	0.0	1.3	21.3	23.4	28.3	14.1	11.6	2.3	23.4	17.8	14.0	3.8	19.8	18.9	4.31
	39.6	2.48	0.0	1.3	17.7	19.8	29.4	17.0	14.8	0.0	48.0	21.4	10.5	2.5	6.8	7.8	—0.56[a]
	38.0	2.50	0.0	0.8	19.8	19.0	21.2	20.5	18.7	24.3	39.9	25.5	6.5	0.6	0.7	2.5	—1.61
Loam	21.0	1.73	0.0	0.0	3.1	5.7	77.8	11.5	1.9	0.0	0.0	0.0	0.5	0.9	22.8	75.8	96.10
	21.2	1.74	0.0	0.0	2.8	4.8	70.5	14.8	7.1	0.0	0.0	0.0	0.8	6.9	16.7	75.6	40.60
	21.4	1.73	0.0	0.0	3.7	2.8	63.7	16.9	12.9	0.0	25.1	7.7	5.2	1.6	6.0	54.4	11.11
	21.5	1.74	0.0	0.0	3.9	2.5	54.5	21.4	17.7	2.3	40.2	7.4	6.1	4.5	1.4	38.1	3.66
Fine sandy loam	8.2	1.23	0.0	0.0	1.2	4.4	86.4	4.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	99.0	157.30
	9.9	1.25	0.0	0.0	1.4	2.1	82.4	9.1	5.0	0.0	10.0	2.2	5.9	1.9	1.6	77.8	51.65
	12.1	1.25	0.0	0.0	0.9	1.3	72.8	13.9	11.1	2.5	16.1	6.1	6.6	1.7	7.1	59.9	13.62
	14.5	1.27	0.0	0.0	1.0	0.5	63.8	19.1	15.6	11.3	27.0	7.3	7.5	2.2	1.2	43.2	5.68

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[a] Minus sign signifies that accumulation predominates over loss to wind erosion.

Table 3

Threshold of wind velocity for raising free dry particles of quartz (9)[a]

Particle diameters, mm	Spec. gravity	Threshold velocity, m/sec	Particle diameters, mm	Spec. gravity	Threshold velocity, m/sec
0.005—0.01	2.65	>16.5	0.05—0.10	2.65	4.1
0.01—0.02	2.65	10.3	0.10—0.15	2.65	3.8
0.02 – 0.05	2.65	6.4	0.15—0.25	2.65	5.0

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[a] Wind velocity at 15 cm height, length of experimental area 91 cm.

Table 4

Adhesion force of dry blocks consisting of particles with various diameters and their susceptibility to abrasion by fine sand (9)

Particle diameters, mm		Load weight in g, required for crushing a cylindrical block measuring 1.25 x 1.25 cm	Quantity of fine particles forming per minute, in g, using 12.8 g of destructive agent[a]
Ca – clay	<0.005	54.23	Traces
H – clay	<0.005	44.20	"
Na – clay	<0.005	37.85	"
Quartz	0.005—0.01	2.02	1.0
"	0.01 – 0.02	0.12	8.0
"	0.02—0.05	0.28	34.3
"	0.05—0.10	Slight crumbling	—

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[a] Wind velocity 9.8 m/sec

igh resistance of dry clay blocks to break-
still fails to indicate resistance of clay
to wind erosion. Clods being formed from
intensively disintegrate into easily-blown,
fine aggregates as the result of alternate
zing and thawing, wetting and drying. Clay
, especially carbonate ones, are hence
subjected to spontaneous blowing on an
e field, independently of available ex-
eous material.

lods being formed by silt particles (0.01-
mm in diameter) do not granulate and af-
rying remain as a compact mass moder-
resisting disintegration in wind erosion
ess. Fine sand particles lack cohesive
while coarse silt particles (0.02-0.05 mm
eter) are between fine silt and fine sand
cles in this force.

ne sand particles deprived of cohesion
nonstable clods which rapidly break down from impacts with free sandy particles transported by the wind. A few of the latter suffice to destroy the thin crust and to expose the soil particles subjected to blowing. In coarse-textured soils, wind erosion thus usually starts on the elevated parts of the relief and spreads fan-like to the leeward side. Therefore, elimination of blown-off spots at elevated places is a definite precondition for successfully guarding soils against wind erosion over the entire field.

Effect of Calcium Carbonate on Soil Erosion

Carbonate soils are often severely subjected to wind erosion. Experiments over several years have shown that the addition of 1%-5% calcium carbonate to clay loam soils perceptibly decreases cloddiness and mechanical stability of lumps, at the same time increasing soil erodibility (14). The addition of 0.3% and 10%

of calcium carbonate has a slight effect, differing in various soils. In sandy loamy soils, as calcium carbonate is added, the cloddiness and textural strength increases, while soil erodibility by wind decreases (Table 5).

The addition of only calcium carbonate exerts a slight effect on the increase in water-stable aggregates, excluding those <0.02 mm in diameter (Table 5) which yield easily to blowing. These result not so much from soil dispersion as from addition of calcium carbonate as silty particles having a slight cementing quality and the secondary aggregates and clods (forming during participation of these particles) are unstable. Addition of calcium carbonate to clay soil weakens the cohesion of clay particles and the inter-aggregate bonds favoring formation of soil lumps. Here there may occur the flocculation phenomenon which is distinctly observed at breakdown of lime in water (13, 14).

Experiments combining the addition of calcium carbonate and decayed wheat straw into various soils yielded analogous results. Quantity of eroded fractions was increased, the clod's mechanical stability decreased, and soil erodibility was intensified. The only differ was that calcium carbonate slightly affecte water-stable aggregates, whereas effect of cayed straw was significant. With addition decayed wheat straw residue, the quantity water-stable aggregates >0.84 mm in diam increased and aggregates <0.02 mm in dia meter (Table 5) decreased. Both these separates tend almost equally to decrease soil erosion (13). However, the increase water-stable aggregates >0.84 mm in diam proved trivial as compared with the decrea in the fraction <0.02 mm in diameter. As pected, decayed straw promoted an apprec increase in the soil's erodibility as evident from data in Table 6.

In soils high in calcium carbonate conte the decayed straw increased the erodibility more than in soils with a lower content. T most wind soil erosion was noted in soils w most decayed organic matter and calcium carbonate.

The given data are significant from a pr cal standpoint. In arid regions, soils have high carbonate content and in certain soils,

Table 5

Effect of calcium carbonate upon soil structure and erodibility of soil by wind (14)[a]

Soil	Amount of $CaCO_3$ added, %	% of water-stable aggregates In mm >0.84	$0.84-$ -0.02	<0.02	% of dry aggregates In mm >6.4	$6.4-$ -0.84	<0.84	Mechanical stability of dry clods	Erodibility by wind,
Chernozem silt loam	0	2.0	72.1	25.9	57.8	17.5	24.7	90.6	0.
	1	2.1	72.2	25.7	42.0	15.7	42.3	82.1	0.
	3	2.2	72.7	25.1	42.7	14.4	42.9	84.9	0.
	10	2.1	67.9	30.0	45.3	18.3	36.4	89.5	0.
Chestnut silt loam	0	1.6	73.1	25.3	50.3	13.0	36.4	84.4	0.
	1	1.5	71.8	26.7	41.2	15.4	36.7	75.5	0.
	3	1.3	72.5	26.2	40.0	14.7	45.3	77.8	0.
	10	1.4	68.1	30.5	50.5	16.1	33.4	85.8	0.
Brown fine sandy loam	0	0.9	85.7	13.4	45.1	12.6	42.3	83.5	0.
	1	1.2	87.0	11.8	42.1	10.7	47.2	82.2	0.
	3	1.0	85.4	13.6	41.0	10.6	48.4	80.4	1.
	10	0.9	80.5	18.6	44.9	12.4	42.7	83.2	0.
Reddish chestnut loamy fine sand	0	1.2	94.9	3.9	8.6	2.4	89.0	31.2	16.
	1	0.8	95.7	3.5	10.4	3.1	86.5	31.4	14.
	3	1.6	92.7	5.7	16.9	3.6	79.5	49.7	7.
	10	0.9	88.6	10.5	31.0	8.4	60.6	68.1	2.

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[a] Experiments were started in October 1948. In table are shown average data from determ tions in October, 1949, September, 1950, April, 1952 and February, 1953.

Table 6

ertain properties of soils following 2 1/2 years after introduction of calcium carbonate and shredded wheat straw (14)[a]

Quantity and type of material added	$CaCO_3$	Organic matter	Mechanical stability of dry clods	Quantity of dry soil being eroded, diameter <0.84 mm	Erodibility, tons/acre
	In %				
Not added (control sample)	0.67	2.53	62.6	34.3	0.33
3% $CaCO_3$	3.13	2.57	59.6	43.0	0.61
The same, plus 3% straw	3.41	2.78	50.6	55.3	1.60
10% $CaCO_3$	9.10	2.43	59.1	46.2	0.84
The same and 10% straw	9.08	4.09	53.1	64.6	2.95
1% straw	0.67	2.63	56.9	40.0	0.54
5% straw	0.67	3.33	55.5	46.5	0.90

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[a] Average data for silt-loam, sandy loam and clay soils, of the brown, reddish-chestnut
nd chernozem zones, respectively.

onate-enriched layer is near the surface.
ivation of such soils often enriches the
ed layers with carbonate, especially in the
led areas. Intensive wind soil erosion on
ated relief elements occurs both from in-
sed wind velocity and from increased car-
te content. In wind erosion, the carbonate
mass blown from the elevations promotes
erosion in adjacent fields, hence causes an
nsion in general areas of eroding soils.
e elevated areas containing carbonate soils
potentially very dangerous, from an erosion
dpoint, for the surrounding lands and re-
e special soil conservation measures (e.g.,
ing to grasses).

ct of Organic Matter on Wind Soil Erosion

igh humus content in soil does not always
rt development of wind erosion. This was
d several times in our literature as early
the works of Dokuchayev and his co-
kers in the chernozem zone, and in foreign
ature for the conditions of the Canadian
nozem soils (18, 19, 20, 23). A quite ap-
iable development of wind erosion was
d in sandy and sandy loam soils where in-
sed humus did not promote formation of
e aggregates and clods preventing wind
ion. Wind erosion develops very inten-
y if high humus content is combined with
eased carbonate content.

aboratory tests were undertaken with the
ion of finely-ground wheat straw into
ous Saskatchewan soils (Table 7).

Data in Table 7 showed that in decomposition, straw greatly affects soil aggregation; however, this effect was not uniform or constant in all the samples. Table 7 shows there were more erodible particles in chernozem-like soils than in other soils studied. Other field tests showed that decomposing organic matter (straw or freshly-cut alfalfa) spread on the soil promotes the aggregation of soils and an increase of water-stable aggregates >0.84 mm in diameter, a decrease of those <0.02 mm in diameter, a certain increase in content of soil clods >0.84 mm in diameter, and a decrease in wind soil erosion. As more organic matter is added, the effect becomes greater. Other results in soil aggregation were derived following decaying of organic matter after two to five years from the time of adding straw to the soil. Decayed organic matter exerted little or no effect on increased quantity of water-stable aggregates >0.84 mm in diameter, but content of average-sized water-stable aggregates did increase; amount of water-stable aggregates or particles <0.02 mm in diameter decreased, as did the soil's cloddiness. The soil's susceptibility to wind erosion increased (16).

Hence decomposed organic residue or its decay products create fine water-stable aggregates (by way of cementation of the silt and clay particles) able to resist water erosion but readily susceptible to wind erosion (14, 16). This condition was quite noticeable in soils with high carbonate content.

The action of organic residues at various decomposition stages upon soils' aggregation and

Table 7

Effect of wheat straw upon soil structure (Chepil)[a]

Soil	Organic matter, October 1940	Erodible particles with diameter <0.84 mm							
		August, 1941		September, 1942		September, 1944		September, 1946	
		With straw	Without straw	With straw	Without straw	With straw	Without straw	With straw	Without straw
Brown, desert-steppe									
Fine clay loam	2.49	25.6	41.6	55.3	56.4	29.4	39.6	36.8	36.8
Silty fine clay loam	3.99	20.9	19.6	61.0	56.4	61.6	38.7	68.4	57.0
Fine clay loam	3.51	30.1	44.9	68.5	76.9	68.9	72.9	75.0	70.7
Clay loam	3.51	32.4	67.5	84.3	81.9	85.0	87.8	87.4	89.7
Sandy loam	3.06	47.3	86.1	87.9	89.7	88.6	91,2	88.8	85.8
Average for brown soils	3.31	31.3	51.9	71.4	72.3	66.7	66.0	71.3	68.0
Dark-brown, desert-steppe									
Fine clay loam	3.53	19.6	25.3	53.7	42.3	36.4	23.4	19.8	17.1
Silty fine clay loam	4.91	42.3	60.2	78.1	86.5	81.4	80.3	82.5	79.4
Silty clay loam	4.91	29.5	47.9	79.2	84.0	75.9	75.2	80.9	77.2
Clay loam	5.52	45.6	58.9	86.7	89.8	84.4	87.3	87.8	86.1
Sandy loam	2.65	60.3	75.3	90.9	92.2	91.4	92.7	92.2	89.2
Average for dark-brown soils	4.30	39.5	53.5	77.7	79.0	73.9	71.8	72.6	69.8
Chernozem-like soils									
Silty fine clay loam	9.95	39.6	58.7	67.3	73.3	71.0	77.6	74.2	80.3
Fine clay loam	6.31	37.8	54.1	75.5	82.2	79.2	79.9	80.0	78.0
Silty clay loam	7.86	43.9	66.2	81.7	87.9	83.4	90.1	79.8	86.1
Clay loam	7.61	47.5	70.0	79.9	83.6	82.1	84.7	83.4	83.7
Sandy loam	3.66	48.8	86.4	88.2	95.1	91.4	95.9	94.3	95.6
Average for chernozem-like soils	7.08	43.5	67.1	78.5	84.4	81.6	85.6	82.3	84.9

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[a] The straw was introduced at a rate of 25 tons/ha in October 1940 and again in August 1941. The soil was in a moist and exposed state.

nature of the aggregates forming thereby hypothetically explained by instability of al organic matter decay products (5, 22). ger, wind-resistant secondary aggregates formed mainly during decay of organic mat- and are preserved until primary decompo- on products, especially polysaccharides, present in the soil. With breakdown of al organic matter decay products by other roorganisms, there occurs in the soil a de- position of the coarser primary and ondary aggregates and an exceedingly fine cture formation (21) which is unfavorable ense of protecting soil from wind erosion.

)rganic matter is hence quite necessary for easing soil fertility but the high humus con- forms microstructural elements and in- ases the soil's susceptibility to wind erosion. eliminate or reduce the quite fine structure nation of the soil, one has to apply and con- tly add as much plant residue as possible. directly protects soils from wind erosion (as a result of decomposition) promotes continuous formation of cementing materials yophilic and lyophobic colloids, an increase icroorganisms and their secretory prod- , as well as of polysaccharides being syn- ized by certain microorganisms etc.), led for developing wind-resistant aggregates clods. The plant residues should hence be on the soil surface and be embedded htly; gradually decomposing, they will pro- cementing substances over a prolonged od (14, 16).

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SOILS OF CENTRAL CHINA AGRICULTURAL REGIONS (FROM FIELD OBSERVATIONS IN THE YANGTZE RIVER BASIN)

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According to the physico-geographic division traditionally accepted in China, Central China encompasses a vast territory extending from the Tsin Ling Shan (Mts.) and the Hwaihe[1] River on the north to the Nan Ling Shan (Mts.) in the south, and from the shores of the East China Sea to the foothills of the Sino-Tibetan Mts. (4). Most of this territory, with an area of more than 1000 km^2, is within the Yangtze River basin. Here more than 200 million people live, around 30% of all the tillable land is located, and almost half the agricultural output of China is produced.

According to the soil and complex natural regions (5) developed by Chinese scientists, the area of the basin under consideration relates to two zones of the humid region of the subtropical belt — "northern subtropical" and "central subtropical." The zonal soil groups are: for the first zone, the yellow-cinnamon-brown soils of mixed deciduous-evergreen broadleaf-coniferous forests; for the second, red earths and yellow earths of the evergreen broadleaf-confierous forests. The transition between them is very gradual; the boundary is arbitrarily drawn along the Yangtze River and a line rounding the Red Basin of Sechwan from the north.

In each zone there are several natural soil-bioclimatic provinces, including plain, "semi-mountains," or mountain-plain (combination of mountains with inter-mountain depressions) and mountainous.[2]

With all the complex geomorphological structure of such a vast territory, three types of relief stand out fairly clearly in it: 1) contemporary fluvial and lacustrine-fluvial plains, 2) hilly and low-mountain hilly territory, representing mostly greatly denuded ancient river terraces, and 3) mountains of average height.

We became interested in territories of most intensive agricultural use; these are the plain and hilly relief territories. These are above all the lacustrine-fluvial plains along the Yangtze River from its outlet of "three gorges" to the sea; next are the Chuan-tze alluvial plain in the western sector of Sechwan province, the hilly regions north and south of the Yangtze River, and the largest intermountain depressions (Nanyang, Han Chung and others).

The Yangtze River lacustrine-fluvial plains lie at the transition from the northern to the central sector of the humid-subtropical region. Climatic conditions are fairly similar over the entire extent. Average July temperatures are 27-29°C, January 2.5-5.0°C (with deviations not lower than 0), yearly mean 17-18°C. Mean annual precipitation is 1000-1300 mm. Rain falls mainly in the warm half of the year (66%-72%), mostly in May, June and July.

In small-scale soil charts, there are shown here the "alluvial" soils combined with gley soils of rice fields (1) or "meadow-bog, old irrigated, carbonate-free, in places acid ("rice") soils" (2). In the maritime sector, one notes "chloride solonchaks, solonchak-like light meadow and in places bog soils in the marine and delta deposits" (2).

We became acquainted here with a broad spectrum of diverse hydromorphous soils of varying agricultural importance. We give a brief outline of them below.

Alluvial soils proper, flood plain, regularly flooding, occupy only a narrow belt along the river, bounded by shore embankments. Most of this soil is coarse clay loam and sandy loam, slightly carbonate or neutral, with slight humus content. An annual deposit by fresh river sediments promotes fertility of the soil. Soils are planted to grain crops in the cold half of the year. In the warm half, they are inundated.

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[1] The spelling of several of the Chinese place names given in translation is provisional due to obscurity resulting from Russian spelling in original text.-Tr.

[2] Cf. in the present issue of the journal the map appended to the review of report (5).

Alluvial — meadow soils with low humus content occur in the riparian and maritime areas of the delta plain, located somewhat above the high water levels in the river. They also occur in other regions of terraces above the flood plain. Such soils can also develop in other places which are protected from flooding. Another mandatory condition is needed in this case, i. e., a coarse texture of the alluvium. In the opposite case, soils develop according to the humus-bog type, or more commonly, they are reclaimed under a rice crop and converted to the special rice field soils. The condition noted (coarse texture) is at the same time a common feature of alluvial-meadow soils in the Yangtze River valley and its tributaries. This is evidently common under humid subtropical conditions. The coarse texture is explained by conditions of alluvium deposit — close to the main river bed or in the tidal zone, and also by the young soils in which conversion to clay was not yet manifested. Profile differentiation by genetic layers was almost lacking; one notes only a faintly colored gray humus layer. Carbonates are distributed throughout the profile or faint traces of inward erosion are revealed. Only the easily soluble salts are leached intensively, as can readily be seen in the soils developed on salty alluvium (in the maritime belt).

In the rainless periods the soils quickly dry out and the water table drops; the capillary rise of moisture does not always compensate for loss to evaporation. In spite of high annual precipitation, droughts sometimes ensue.

Alluvial-meadow solonchak soils, developed in the maritime belt of the delta plain, have all the features of the previous soils but differ by having an appreciable content of easily soluble salts. The latter, mainly sodium chloride, are concentrated in the ground waters and are residual from the time of leaching the river alluvia by sea tides. According to Syung-Yi (6), these soils contain about 1% humus, 6%-8% of carbonates (in conversion to calcium carbonate). The content of easily soluble salts is very dynamic: solid residues, 0.1%-0.4%; chlorides, 0.08%-0.24%; sulfates, 0.02%-0.05%; alkalinity from normal carbonates is absent, but total alkalinity from bicarbonates is increased, up to 0.09%; pH = 8.3-8.7. Externally they resemble the light meadow soils of the Central Asian desert zone, but their salt regime is quite different. In the hottest period (coinciding with the season of most rainfall), the rainwater soaking through the light soils is added to the ground waters and freshens them. From autumn to spring, the ground waters become saline because of evaporation, and the salts rise to the soil surface. Hence the salting of the soils is manifested seasonally, toward the end of the dry period, i. e., toward spring — this damages the spring sowings, especially the young cotton plants. However, this salinization does not occur everywhere o every year. The territory of solonchak soils has a dense network of interconnecting channe serving to drain off the surplus rain and grou water.

All the alluvial-meadow soils are tilled to the maximum and are used throughout the yea almost entirely under dry land cropping. The chief ones are: crops in the cold half of the year — wheat, barley, horse beans; warm half of the year — soybeans, corn, sorghum, cotton, jute, ramie, etc. Almost all cotton crops are adapted to alluvial-meadow soils. Such soils are slightly suited to rice crops because they have good water permeability.

In the territory of interest to us, solonchal have a very insignificant place. Among them, we can include a narrow (up to 5 km) seashor belt, bounded by embankments and comprisin the contemporary tidal zone. These are as y non-formed water deposits, containing (from Syung's data [6]), 0.2%-2% of easily soluble salts, including 0.1%-1.1% sodium chloride.

Gley and gley-like "rice" soils comprise over half the entire arable area and most grai production comes from them. They occur wi ly not only in the plains but also in hilly regio of the central subtropical zone where they tak up all the terraced ravines and slopes.

Rice soils are diverse in many features si they develop under various zonal-climatic conditions and from various preceding "nonrice" soils. The most active factor conditioning bo their differences and their similarities is the actual rice crop and those agricultural systen related to this crop. Herein must be noted th great age of the ricefields (usually well know to the peasants for each field) reckoned in centuries and milleniums.

According to features of gleying state, evo by prolonged flooding and anaerobiosis, rice soils can be included under the bog group and can be considered a special "crop variant" of bog soils or a "bog variant" of crop soils. I water regime and humus, some of them are comparable with meadow-bog (or humus-bog) soils, while others (low in humus and strongl gleyed) with clay-bog soils.

As zonal features of rice soils in the humi subtropics, one can include an acid reaction, a considerable secondary gley state, and the leaching of colloid iron, aluminum and silico compounds. The latter mainly occurs at slig depth, within limits of water table fluctuation

An intensive gleying of rice soils througho the profile is typical for fields with an annual winter accumulation of water (the system of rice sowing by "celestial" irrigation), and fo constantly high water table. In both cases, he soil is supersaturated the year round and othing but rice is planted on it.

In other cases, with alternating rice plantngs with dry land winter crops, intensive leying is noted only in the deep horizons (from econd half meter or even deeper). The upper oil horizons, periodically drying and being erated, have signs of slight gleying and oxidizng processes (against a dark blue background, usty ferrous spots and streaks, etc.).

Based on the criteria indicated, one distinuishes gley and gleyish rice soils. In detailed oil mapping, the Chinese soil scientists divide hem further into several gradations by depth nd intensity of gleying.

Rice soils are essentially distinguished by rganic contents, usually 1%-3%. Those with ess humus are the gley rice soils, developed n an allite weathering crust, i. e., on former ed earths and yellow earths. Those with most umus are developed on lacustrine deposits. The rice soils developed on river alluvia are verage in humus content. However, humus ontent also depends on addition of organic ertilizers. In fields adjoining large settlenents, the soils are higher in humus content.

No less considerable are differences in inlexes of acidity and base saturation. The pH-alues in rice soils vary from 4.5-7.5. The nore neutral rice soils occur in the territory f river and lacustrine-fluvial deposits. Theren, of known significance in the addition of caronates from river water during floods often ccurring in previous years. The more acid ice soils develop on an allite weathering rust.

Differences in texture depend on the original exture of the parent rock and upon the age of oil, i. e., upon the degree of secondary clay ormation. Clays and fine clay loam-clay oils predominate.

All the foregoing distinctive features of rice oils have practical significance, testifying o the various conditions of fertility and creatng the need for a differentiated approach during ultivation, fertilization and irrigation. The aws of combination of the features and the conlitions to which they correspond are still little tudied, as are importance of hydrogeological onditions and the geography of these condiions. Earlier, we expressed general conepts of the typical (for a moist subtropical one) stagnant ground waters having no outlet 7). This does not exclude the presence of nobile ground water with horizontal inflow and utflow under appropriate geomorphological onditions. For the reasons indicated, the enetic classification of rice soils still needs urther development.

In dealing with hydro-reclamation problems, it was necessary to distinguish rice soils in the following three categories: 1) rice soils relatively easily freed of excess water in the autumn-winter period and suitable for planting (besides rice) winter crops and legumes; 2) rice soils from which it is difficult to remove excess water and thus only suited to rice planting (without sowings in the winter half year); 3) rice soils sown only to rice (without winter crops) since the uncertainty of reliable irrigation sources forces the accumulation on the actual rice fields of water from precipitation during the winter (rice fields with "celestial" irrigation.

In the first category, one includes diverse rice soils, gley-like, developed on fluvial and lacustrine-fluvial deposits, under conditions of adequate natural or artificial drainage. The removal of excess water in these soils after establishing the rice proceeds in various ways. This is sometimes connected with filtration and the general outflow of ground water to the side along large water-bearing horizons; for instance, on the Chuan-si plain in Sechwan province and on certain alluvial fans at the foot of mountains in Anchoy province, where the soils are underlain by gravel. In other cases, with poor natural drainage, removing excess water proceeds at a lesser depth (although deep enough for sowing winter crops), by means of only a local horizontal outflow into nearby canals, with a thick network of the latter and at corresponding water level drop in autumn. The winter drying of these soils promotes their fertility. At present there is a mass transition in them from one to two rice crops per year, plus legume crops in the winter, i. e., a change to year-round cropping.

In the second category are fley rice soils developing under unfavorable drainage conditions. There may be various causes making removal of excess water difficult and hence to choose means of reclamation, the detailed study of actual areas is needed. As most typical, one can note two cases: 1) at slight penetrability of the parent material and stagnant ground water, relief has a depression characteristic and hence in the intersecting canals, the water level in autumn is insufficiently lowered; 2) the abundant lateral inflow of ground water under the rice soils, continuing after the rice season. Such conditions are present in certain valleys. For reclamation of these soils, one must seek means of removing excess water in winter to create conditions for year-round cropping.

In the third category are included mainly the gley rice soils developed on an allite weathering crust, distributed on the terraced slopes and in ravines in the hilly-mountainous regions. In comparison with the former, they are considered the least fertile because rainwater, accumulating in the fields in the winter and being replenished in summer, is sufficient for but one rice crop. In the given case, the problem of removing the excess water is solved most simply. Great difficulties confront the irrigation workers in assuring regular irrigation. The most available method of irrigation in hilly and mountainous regions is the use of local surface runoff with the aid of small dams and reservoirs.

The productivity grouping of rice soils can at the same time be regarded by dividing them by properties, modified by different origin and development. Thus, soils in river deposits (less acid and higher in humus content) and soils in the allite weathering crust (more acid and lower in humus content) can be regarded as different genera, while the soils distinguished by degree of gleying (gley-like and gley) can be considered different species of the given group of rice soils.

Yellow cinnamon-brown soils typify the dry land fields of the northern zone of the subtropical region. Outside the plowlands, one finds only greatly eroded soils on the steep slopes and rocky soils in the mountains.

According to climatic conditions, the zone of yellow cinnamon-brown soils differs from the one located farther south by a colder winter and less precipitation. Mean annual temperature in the first zone is 15-18°C, in the second, 18-20°C; mean temperature in January is respectively 0-4°C and 4-8°C; July, 26-27°C and 25-29°C; frostfree period is 250-300 and 300-350 days; the total of active temperatures (above 10°C) comprises 4500-5500 and 5500-7000°C; total annual precipitation is 750-1000 and 1000-1700 mm. In both zones, maximum precipitation falls in the summer months.

By degree of denudation of single-age ancient terraces of the Yangtze and its tributaries, one can judge the geological age of similar zonal-climatic differentiations, at least in respect to atmospheric precipitation. On the left shore area in the northern subtropical zone, typified by less precipitation, there are developed the less disjointed terrace formations, territories of undulating-hillocky relief predominate, and the original plain watershed areas are retained. On the right shore in the central subtropical zone with more abundant rainfall, the ancient quaternary terraces (identical in age and origin) have a distinct hilly relief.

The natural zonal differences are significantly reflected in agriculture. In the northern subtropical zone, rice raising is possible only with regular irrigation from permanent sources; rainfall is too sparse for "celestial irrigation." Hence in many regions even plain lands are used only under dry land cropping. In the warm half of the year, corn, sorghum, soybeans, millet, potatoes, buckwheat, hemp and cotton are grown; in the cold half — wheat and barley. In the forested areas, deciduous type and thin-stemmed bamboo predominate.

In the central zone, rice growing "by celes al irrigation" is a widely practiced, historical adopted method, but with additional artificial irrigation, the harvesting of two crops per season is possible. Almost all the listed plan grow well, and in addition many of the more southern ones: sugar cane, camellia, tea, citrus fruits, ramie, jute, tung tree, camphor tree, large-stemmed bamboo and many others

The yellow cinnamon-brown soils, accordin to I. P. Gerasimov and Ma Yung-Chzhi, are in a special place between the cinnamon-brown soils and the yellow earths: "the essence of soil formation in yellow cinnamon-brown soils consists in the processes of metamorphic clay formation and of the initial stages of allit zation at variable soil reaction from slightly acid to slightly alkaline" (1).

Soils of this group are diverse but there ar insufficient data for their systematization. Ou brief observations during a tour of the territor permitted us to note only the following feasible division into groups: 1) yellow cinnamon-brown, 2) yellow cinnamon-brown, gleyed at surface; 3) yellow cinnamon-brown with carbonate concretions and 4) yellow cinnamon brown, eroded.

Long-tilled yellow cinnamon-brown soils proper (typical) develop on rolling plains and smooth hillsides under conditions of sufficient runoff of surface water. For the soil profile, the presence of a low-humus upper layer, clay loam, colored light greyish- or cinnamon-bro is noted. The occurrence of bits of glass, coa and other permanent inclusions indicates the introduction of earthy material during the agricultural development. Thickness of the layer varies greatly — up to 1 m.

The following layer is illuvial, clay and compacted, nutlike in consistency (often even prismoidal-nutlike) with shiny facets. Below 1.5 m, there is a clay weathering crust with unclearyellowish, reddish, light bluish, green ish and whitish spots, and with rounded black-brown ferrous concretions (pea-size inclusion

The yellow cinnamon-brown superficially gleyed, dark (long-tilled) soils develop under unique conditions of seasonal excess moisture Such conditions are developed on the flat undrained watershed plains (the Tanbaihei regio in Hainan province) in slightly permeable clay materials. In three months, two-thirds of the annual precipitation falls here (more than 500 mm) which creates stagnant surface wate In these soils, the upper level down to plowing depth or more is gray, mostly fine clay loam.

nder it there is a darker blue gray, in wet ate being a black layer with rusty spots. Gley- g is combined in it with humus coloring. Depth 40-70 cm up to 1 m. It breaks into nutlike ructure when dried. The transition is gradual; low is a light, finely spotted plastic clay. gns of added material (bits of glass, etc.) are und to depths of 0.5-1.0 m, indicating gleying the agricultural period. One can note yellow nnamon-brown superficially gleyed soils ith a "black level" almost from the surface d to depths of 50-70-100 cm from soils with depressed black level (from 30-50 cm); other- ise expressed, one can classify the given soils cording to occurrence depth, layer thickness d degree of developed humus-gley dark level. he peasants call these "black soils" and re- rd them as less fertile than the yellow cin- mon-brown typical soils which they call ellow soils."

We have certain chemical data of yellow nnamon-brown soils from the northermost gion of their occurrence (Hainan province)[3] d they are given in Table 1. These data ffer from those for yellow cinnamon-brown ils (1) by a neutral and even an alkaline the second profile) reaction and by high se saturation, i.e., the soils described are ore similar to the cinnamon-brown. This sults from our having analyzed soils from e more northern region and having taken the mples in the dry season; in the second pro- le the ground water is at 2 m depth.

Yellow cinnamon-brown soils "with CaCO$_3$ ncretions" (thus their term is translated om Chinese) do not occupy continuous large eas but in the Tanbaihei region they are und fairly often on the riparian slopes of atershed plains. Externally they are ordin- y yellow cinnamon-brown soils with a light- lored (low in humus) upper level but on e surface and in the actual soil there are any calcium carbonate concretions. The ter are mostly rounded; their size is 2-4 cm cross section, often larger. They are very rd, petrified, brownish inside, dull, and licic. Hydrochloric acid makes them foam olently from the outside, but not on the in- de; the surrounding soil does not foam even ar the concretion. According to our obser- tions, the concretions in the given soils are sidual formations. They are common through- t the region, but on level and slightly rolling tershed plains are covered by the typical ey yellow cinnamon-brown soils to a depth om 2.5-3 to 4-5 m. The level with con- etion outcrops on the slopes is formed from e incision of the contemporary hydrographic twork. Thus "soils with concretions" are yellow cinnamon-brown ones, developed on a "concretionary level" of an eroded weathering crust.

Yellow cinnamon-brown eroded soils are common in hilly and mountainous regions. They all have a greatly truncated profile and are low in humus. But the restoration of the soil cover on abandoned eroded land occurs quite intensively. In a few years, the soil is covered with a grassy vegetation, forming a 10-15 cm thick humus layer with its normal friable-blocky structure and cinnamon-brown color. Within this layer, one notes signs of gleying, changing at 25-40 cm to marl of the bedrock or to a clay weathering crust. Greatly eroded soils unsuited for crops are now taken up everywhere by tree plantations.

The red earths and yellow earths of the central zone differ quite sharply in color in a number of cases but are alike in many other respects. It is known that their color differences ranging from bright red to yellow are conditioned by the varying degree of hydration of iron oxides connected with differences in moist conditions (1). The composition of the soil-forming material undoubtedly has significance here.

In the humid subtropical Yangtze River basin, red earths are most common and used in agriculture; they are developed on a clay, kaolinized weathering crust (saturated with secondary iron oxides) of ancient quaternary clay soils and tertiary sandstones. Many Chinese authors describe them; their detailed chemical outline is presented in the report of Li Tsing-kui and Chzhan Syao-nyang (3). They note the deep decomposition of primary material with the formation mainly of kaolinite and iron oxides, including goethite and hematite; along with these secondary minerals and residual quartz, there are also some undecomposed primary alumino-silicate minerals. The clay fraction's elementary composition is uniform throughout the profile; the molecular ratio of silica to sesquioxides typical for these soils and the weathering crusts equals 1.8-2.2. Humus accumulates beneath a grassy-forest cover up to 5%; in cultivated soils, not over 1.5%-2%. All soils are acid and pH = 4.5-5.5.

We will not touch on certain problems concerning these soils.

With greatly broken relief, torrential rains and continuous agricultural use the present soil of the red earth zone can not be regarded without having in mind its constant and repeated erosion and restoration. In a classification of the red earths, it is necessary to consider the facts and phenomena of two orders: first, the differences caused by the soil's stage of development, and secondly, the differences caused by the features of the weathering crust

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[3] The chemical analysis data were kindly sent by l scientists Van Dy-Yu and Chzhen-Zin-fu from nkow.

Table 1

Analytical data for yellow cinnamon-brown soils

Depth, cm	pH		Humus	CO_2	Adsorption capacity, meq	Base saturation %	Total content						Molecular ratio SiO_2/R_2O_3	Particle diameters (mm), %		
							In soil			In clay fraction <0.001 mm in diameter						
	Water	Salt	In percents				SiO_2	Al_2O_3	Fe_2O_3	SiO_2	Al_2O_3	Fe_2O_3		>0.01	0.01—0.001	<0.001
Yellow cinnamon-brown typical, long-tilled																
0—13	7.0	5.7	0.90	0.25	Not det'd.		78.57	12.30	3.42	47.41	22.05	10.53	2.84	61.5	34.5	4.0
13—26	7.0	5.6	0.47	0.24	14.5	97.0	77.84	12.04	3.78	46.90	23.62	10.51	2.64	54.5	40.5	5.0
26—56	7.1	5.6	0.67	0.26	25.7	92.5	66.89	17.05	7.05	46.51	24.62	10.93	2.52	41.0	39.0	20.0
56—124	7.0	5.4	0.54	0.22	29.7	83.0	67.92	16.95	5.81	47.54	24.54	10.03	2.63	48.5	40.5	11.0
124—150	6.7	5.2	0.62	0.16	34.2	76.0	68.38	16.38	5.83	47.54	23.24	10.81	2.63	47.6	39.4	13.0
Yellow cinnamon-brown, superficially gleyed, long-tilled																
0—20	7.8	Not det'd.	1.66	0.53	Not det'd.					43.93	23.77	9.48	2.48	Not det'd.		
20—44	7.8	"	1.56	0.60	"					44.33	25.15	9.10	2.42	"		
44—88	7.8	"	1.42	2.02	"					44.12	26.77	9.41	2.29	"		
88—106	7.9	"	0.60	1.59	"					43.97	24.27	10.74	2.40	"		

which the given soil is forming.

Separation of soils by developmental stages n mapping) reduces to a division by degree erodibility (in tilled fields) and restorability n abandoned lands and forested areas).

Classification according to the layers of the eathering crust requires a more profound udy of this crust. The usual structural proles of the weathering crust prompts a division to at least the three following parts: 1) an pper granular-structural porous part (thickess up to 3-4 m and possibly more); 2) a iddle part — in translation from Chinese — a reticular layer" of mottled, cellular structure, ith hard, reddish-brown nodules, resembling ells and including whitish clayey material; and) the lower part of semidecomposed original aterial. Formation of a "reticular layer" connected with excessive moisture. At its utcropping to the surface, a fairly durable on shell is formed but this subsequently reaks down during secondary weathering and oil formation.

In hilly regions, red earths are developed ainly in the upper and middle parts of the eathering crust and in connection therewith ey differ in structural, hydrophysical and ther qualities. Weathering crusts are intenively eroded in the mountains and soils from the "roots" of the crust, i. e., in the semiroded stony materials. To the same category soils of the humid subtropical region, developed directly on the hard materials, there belong the so-called "black soils of limestones" and the "violet soils" in the calcareous violet shales of the Cretaceous age.

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DISCUSSION

DEFINITION OF TERM "SOIL GROUP"

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Last year, the following definition of soil group was adopted by the first plenary session of the Nomenclature, Taxonomy and Soil Classification Committee.

"A soil group is a large number of soils under uniform bioclimatic and hydrological conditions, with distinct evidence of soil formation, possibly in combination with other processes.

Typical features of a soil group are fixed:

1) by uniformity of the amount of organic matter, by type and nature of their decomposition;

2) by uniformity in decomposition of mineral mass and of synthesis of mineral and organic formations;

3) by uniformity of migration of substances;

4) by uniformity of soil structural profile; and

5) by uniform practices to raise and sustain soil productivity" (2).

Such a definition should have expressed the time factor more adequately.

The basic soil properties and structural profile reflect not only the momentarily occurring soil processes but result from a prolonged and variable process which has transpired up to the present moment. Soil processes react easily to external changes; actual soil profile structure and qualities have much "conservatism."

Just after the felling of timber, in the cut-over area, the addition of organic residues and possibility of their decomposition change abruptly, as does the nature of the migration of materials; i.e., the temporal process of sodding or changing to bog begins. Adhering strictly to the foregoing definitions (points 1, 2 and 3), one should at once classify soil in the cut-over area under another group than forest soil, since the soil-formative process has altered its course. But which group? In structural and basic qua ties, soil in the cut-over area will belong for long time to the old group since soils' structu profile and qualities change slowly.

In the definition, soils of one group shoul typified by uniformity of the soil-forming pro ess throughout a long time interval.

The corrected definition now is:

"Group — is a large number of soils devel oped under uniform bioclimatic and hydrologi conditions in parent materials analogous in minerals and typified by enduring uniformity manifesting basic soil formation (at possible combination with other processes), i.e., by uniform addition, decomposition, synthesis a migration of organic and mineral materials i the soil. Uniformity in soil profile structure and in practices to increase and sustain soil productivity is an important criterion of a so group.

Conventionally, a group is divided into su groups according to criteria connecting a giv group with others, and into species in terms extent of evidence of basic soil formation pro ess; species are divided into types according texture. The latter division is in no way suc cessful. After Blagovidov (1), soil division texture surpasses the framework of genetic classification. A species established from manifestation of the soil-forming process ca not be divided into types according to texture When texture affects this process, it then mu be considered in dividing soils into groups, subgroups, and species.

Hence group, subgroup and species chara terize mainly the processes already accomplished. In soil taxonomy, it is useful to co der the trend of present soil processes as w Thus we propose division of types within a s cies according to direction of the soil-forma process at a given moment, which is fairly e to establish according to the nature of the ve tation, and in the forest according to nature of the humus.

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DECOMPOSITION RATE OF ORGANIC MATTER OF VIRGIN CHERNOZEMS IN NORTHERN KAZAKHSTAN DURING THEIR CULTIVATION

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The turning of virgin soil abruptly alters the regime of organic material in the soil. The improved water conditions in the plowed soil, the high content of dead plant residues, and the turning-over of part of the sod on the surface actively promotes development of microflora, which mineralizes the plant residues.

For solving the many theoretical and practical problems involved in developing a proper system of agriculture for the cultivation of virgin soils, we should know the decomposition rate of organic matter in soil as well as changes in content and qualitative composition of humus. In this paper we present results of investigations on the decomposition rate of the soil's organic matter. The investigations were conducted by an expedition of the Kazakh Institute of Agriculture from 1954-1956 on the sovkhozes "Pobeda Il'icha" (Victory of Il'ich) and Zapadnyy (Western) in Ruzayev District, Kokchetav Region (Northern Kazakhstan) in ordinary and southern chernozems of heavy clay-loam texture.

The quantity of roots in the soil was determined by washing out 25 x 25 x 20 cm soil monoliths three times. The chemical-group composition of the humus was studied by the I. V. Tyurin method (we used the method published in M. M. Kononova's monograph [4]).

The climatic conditions in Northern Kazakhstan are markedly continental. The winters are cold with but little snow; summers are hot, often dry. In the subzone of ordinary chernozems, the yearly precipitation is 300-320 mm, while it is 250-270 mm in the southern chernozem subzone. Seasonal distribution of precipitation is irregular. There is a pronounced summer maximum amounting to around 50% of the average annual precipitation. Under such hydrothermal conditions, the active functioning of soil microorganisms, and hence the decomposition of plant residues, is possible at spring's end with the advent of settled warm weather, and in summer during maximum precipitation. In other periods, low temperatures or dry soil retard the decomposition of organic matter. In summary, in the Northern Kazakhstan chernozems, after plowing there occurs a retarded decomposition of root and harvest residues. Table 1 presents data on the content of roots in the soil and decomposition rate of sod after it has been plowed.

As the data in Table 1 show, in ordinary chernozem, there is 1.4 times as much plant residue in the soil as in the southern chernozem. A year after turning the sod over, in ordinary and southern chernozems the roots are 18%-19% decayed, and in two years, about 50% of their initial quantity has decayed. Even four years after plowing virgin chernozem, we can find in the plowed layer sod lumps that have not yet rotted. This indicates a gradual breakdown of plant residues in the Northern Kazakhstan chernozems. The intensity of the decay process depends greatly upon the time and means of tilling. Under conditions of retarded sod decomposition, moldboard plowing of twice-plowed land and soil after the third crop returns the undecomposed and partly decomposed roots to the surface where they dry out and mineralize gradually. Surface cultivation of the second crop, (and in fallow land and weed patches, of the third) following the plowing of virgin soil preserves the sod from rapid mineralization and assures optimum conditions for humification.

The data in Table 2 indicate that, with surface cultivation, intense decomposition of root residues occurs in the 0-10 cm layer and in the 10-20 cm layer their mineralization advances much more slowly. With yearly plowing, mineralization of root residues is increase throughout the plow layer. Surface cultivation of the second crop after plowing the virgin sod guarantees a higher yield of spring wheat. In our tests in ordinary chernozem, we got an increase of 1.1 cntr/ha, and in southern chernozem, 1.6 cntr/ha (Table 3).

The increased yield of spring wheat with surface cultivation after the second crop is

Table 1

Content of plant residues in the 0-20 cm soil layer

Object of study	Ordinary chernozem "Victory of Il'ich" Kolkhoz		Southern chernozem, "Western" Kolkhoz	
	Root residues			
	cntr/ha	Decomposition, % of virgin soil	cntr/ha	Decomposition, % of virgin soil
Virgin soil before plowing	238.8	—	165.4	—
Spring wheat on once-plowed virgin soil	192.0	19.4	136.0	18.1
Spring wheat on twice-plowed soil	115.5	51.6	84.3	48.1
Fourth wheat crop after turning the soil	57.2	75.7	34.2	79.3

Table 2

Effect of methods of tilling virgin soil layer on decomposition rate of sod of medium-humus chernozem, cntr/ha

Soil cultivation methods	Content of roots in layers in cm		Total in 0-20 cm layer
	0–10	10–20	
First crop	57	79.0	136.0
Second crop (surface cultivated)	38.5	71.5	110.0
Second crop (annual plowing)	41.0	43.3	84.3
Third crop (surface cultivated)	27.5	36.7	63.2
Third crop (annual plowing)	31.4	14.0	45.4

Table 3

Effect of soil cultivation, after second crop following turnover of virgin soil, on spring wheat crop, cntr/ha

Cultivation methods	Ordinary chernozem			Southern chernozem		
	1955	1956	Average for 2 yrs.	1955	1956	Average for 2 yrs.
Plowing 20-22 cm deep	14.6	16.9	15.7	7.8	15.1	11.4
Surface plowing with shallow moldboard plows	15.7	17.4	16.6	8.2	17.8	13.0

explained mainly by the improvement in moisture conditions resulting from the development of more closed structure in the plow layer, causing a decrease in nonproductive water losses due to wind. The increased moisture of the surficially cultivated soil develops more favorable conditions for the decomposition of organic residues accompanying their humification.

The studies of Kononova (5), Vinokurov (2), Baranovskaya (1) and others have established that with prolonged plowing of virgin soils or once-plowed land in perennial forage crops, humus loss occurs and its qualitative composition changes.

We took samples from virgin soil and from plowland six-eight years old (Table 4) to determine the content and composition of humus.

The data derived indicate that, during the time elapsed after the turning over of virgin soil (under conditions of annual moldboard plowing), the total carbon content in the plow layer decreases somewhat; by 0.25% in ordinary chernozem, which comprises 5.2% of initial content in the virgin soil; and by 0.33% in southern chernozem, that is, by 11.1% of the original.

Variations in the humus composition of ordinary chernozem after eight years of continual plowing of reclaimed virgin soil proved insignificant. In the southern chernozem, after six years of plowing, variations in humus composition are more noticeable — there occurs a certain decrease in the content of humic acids and an increase in content of fulvic acids and insoluble humic residues.

Thus both the content and the composition of the ordinary chernozem humus is more stable than that of southern chernozem. It can be assumed that the virgin southern chernozems will be plowed more quickly and will need the addition of organic matter, in comparison with ordinary chernozems.

Conclusions

1. In Northern Kazakhstan chernozems there occurs a retarded decomposition of organic matter. After the virgin soils are turned over, decomposition of the root mass takes three to four years.

2. The decomposition rate of organic residues after plowing the virgin land depends upon subsequent tilling methods. Annual moldboard plowing, turning the undecayed root residues to the surface, intensifies their mineralization. Surface cultivation of once-plowed land for the first two years causes more favorable conditions for decay of plowed sod.

3. Eight years after turning the virgin soil, with annual plowing the humus content in the plowed layer of ordinary chernozem decreased by 5.2% as compared with the original content in the virgin soil; in the southern chernozem, by 11.1%.

Table 4

Group composition of tilled horizon in Northern Kazakhstan chernozem humus (Analysis after I. V. Tyurin)[a]

Soil	Land use	Humus	Carbon	Humid acids				Fulvic acids (total)	Insoluble residue (humus)	C of humic acids / C of fulvic acids
				Separates						
		In percents		I	II	III	Total			
Ordinary chernozem	Virgin soil	8.16	4.81	3.6	19.5	8.1	31.2	18.3	34.1	1.60
	8-year plowing	7.84	4.56	1.2	20.2	8.2	29.6	18.3	36.5	1.55
Southern carbonate chernozem	Virgin soil	5.10	2.97	—	21.2	7.0	28.2	23.3	41.3	1.08
	6-year plowing	4.54	2.64	—	19.2	5.5	24.7	28.3	44.3	0.85

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[a] Content of individual groups of humus materials is given in % of total organic carbon in the original soil.

4. The chemical group composition of ordinary chernozem humus changed but slightly after eight years of annual plowing.

In the southern chernozem as early as the sixth year of plowing, the humic acid content in the humus has noticeably declined. The humic-fulvic acid ratio decreased at the same time from 1.08 to 0.85.

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CHARACTERISTICS OF THE ORGANIC MATTER IN THE PRINCIPAL SOILS OF ROSTOV REGION[1]

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The I. V. Tyurin method was used to study the group and fractional composition of humus in the soils of Rostov region. We chose for study: 1) chernozems — ordinary leached — of the Zverev State Sector (GSU), the southern leached of the Tarasov GSU, the fore-Caucasus carbonate of Tselin GSU, the northern Azov carbonate of the Aksay steppe from virgin soil and old plowed areas; 2) chestnut-dark for the chestnut group of Morozov GSU, the chestnut of Zimovnik GSU; 3) solonetz light-chestnut of the Budenny farm in the Proletarian district and 4) sod-meadow of the Don River flood plain. The soils are course clay and fine clay-loam in texture.

As analytical results show (Table 1), in the Rostov chernozem soils, the C:N ratio will vary within the limits of 10; in chestnut soils, the humus is somewhat richer in nitrogen and the C:N ratio amounts to 9-8. In all soils, one regularly observes a high relative nitrogen content in the lower levels, since the C:N ratio decreases with depth everywhere.

The fractional composition of the humus in the soils studied is typified as follows. These soils contain many substances being extracted by an alcohol-benzene mixture (of bitumens). The amount of humus material being extracted during decalcination is also not great, with the exception of solonetz (in the compacted horizon of which it comprises 8%), sod-meadow and southern chernozem.

In the humus, there predominates the humus material being extracted by decinormal alkali (free and combined with calcium); somewhat less (around 30%) of "humins", i.e., those permanently combined with the mineral part of the soil. The group of substances being extracted by the alternate processing of the soil by alkali and acid comprises around 10% in most soils. This fraction is lacking in sod-meadow soil.

Chernozem soils are typified in group composition by prevalence of humic acids over the fulvic acids. They are somewhat more plentiful in the Northern Azov chernozem than in the southern, ordinary and fore-Caucasus chernozem; amount of humic acids gradually decreases with depth in the Northern Azov, southern, and fore-Caucasus chernozems; in ordinary chernozem, this occurs more abruptly and in the lower horizon, fulvic acids exceed the humic ones.

Very typical also are the differences in content of the first fraction of humus materials. In ordinary and Northern Azov chernozems from the Aksay virgin land, it is >50%, which indicates a more manifest new formation of decaying in comparison with the southern and fore-Caucasus cases. In the Northern Azov, southern and fore-Caucasus chernozems, one notes a relative increase of the first fraction with depth (free and combined with calcium); this is evidently conditioned by a more intense decomposition of the newly-formed humus materials in the upper horizons.

Distribution of the first fraction along the profile and the ratio in it of humic to fulvic acids indicates a more abrupt change in conditions of new formation and decomposition of humus materials with depth in the ordinary chernozems than in the Northern Azov, southern, and especially fore-Caucasus types.

Attention is drawn to the uniformity of the group composition of the humus in fore-Caucasus chernozem along the entire profile and the greater relative content of "humic" materials in it. The content of humic acids, in ordinary, southern, and Northern Azov chernozems is one-two times greater than the insoluble residue. It is less (1.0) in fore-Caucasus chernozem. Evidently such a difference in the humus

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[1] The study was conducted by the Faculty of Soil Science and Agronomy at the Rostov State University under supervision of V. V. Akimtsev.

Table

Percentages of humus composition in principal soil groups in Rostov region

Soil	Land utilization	Depth, cm	In original soil			Extracted by alcohol-benzene mixture	Extracted during decalcination
			C	N	C : N		
Ordinary chernozem. Sverov GSU	Fallow	0–20	3.96	0.37	10.6	2.7	2.9
		70–80	2.11	0.22	9.6	2.4	8.0
		100–110	0.70	0.09	7.4	7.1	0.0
Southern chernozem. Tarasov GSU	"	0–20	3.39	0.32	10.6	2.3	8.8
		55–65	1.88	0.18	10.6	2.5	4.5
		80–90	1.12	0.13	8.6	0.9	0.0
Northern Azov chernozem Aksay steppe	Virgin soil June 1955	0–20	2.83	Not det'd.			
		50–70	1.35	"	"	"	
		120–140	0.35	"	"	"	
"	Wheat June 1955	0–20	2.52	0.29	8.7	Not det'd.	
		60–80	1.21	0.17	7.2	"	"
		120–140	0.41	0.08	5.2	"	"
"	Virgin soil[a] 18 May 1955	0–20	3.34	0.32	10.4	4.5	4.5
		20–40	2.34	0.26	9.1	1.8	0.0
"	Old cultivated[a] soil, 18 May '55	0–20	3.06	0.32	8.3	2.75	2.9
		20–40	2.49	0.26	9.4	2.36	0.0
Fore-Caucasus carbonate chernozem. Tselin GSU	Fallow	0–20	2,82	0.26	10.6	2.8	2.6
		55–65	1.52	0.14	10.9	4.0	2.8
		80–90	1.03	0.11	9.0	3.8	0.0
Dark-chestnut. Morozov GSU	"	0–20	1.51	0.17	8.7	3.8	1,3
		25–35	1.42	0.18	8.0	2.1	1.4
Chestnut. Zimnovnik GSU	Virgin soil	0–10	2.19	0.24	9.2	1.6	Not det'd.
		15–25	1.30	0.12	10.5	2.8	
		35–45	0.73	0.09	8.0	4.0	"
Solonetz. Proletarian Dist., Budenny kolkhoz	"	0–8	1.57	0.18	8.7	1.0	3.8
		11–21	1.24	0.15	7.9	1.1	8.0
		30–40	0.31	0.05	6.0	2.0	2.5
Sod meadow flood plain of Don River	"	0–15	2.33	0.23	10.0	3.5	6.0
		40–50	1.38	0.17	8.1	2.0	8.0
		90–100	0.74	0.12	6.1	—	—

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[a] Analyst I. P. Luk'yanova.

is connected with the more intensive decomposition of organic substance in fore-Caucasus chernozem in comparison with the ordinary type. One can assume that the large amount of mobile forms of humic acids in ordinary chernozem creates better conditions for the structure, formation and development of microbiological activity. In this respect, they have certain advantages over the fore-Caucasus type which has more insoluble residue in it. This is manifested morphologically in the mere distinct granular structure of ordinary chernozems, and in the coarser and more friable structure of the fore-Caucasus type.

On the basis of the data derived, we note the following typical features of the matter in the chernozem soils under study. In ordinary chernozems: a) humus formation occurs with the predominance of humic acids over fulvic acids (C_1 = 52%-57%; C of humic acids: C of fulvic acids = 2.3), b) in the profile's lower part, there is a relative increase in fulvic acids, and c) in the humus, the more mobile forms prevail over the humins. In the fore-Caucasus chernozems: a) the processes of synthesis are expressed more weakly, with a relative decrease in the role of humic acids (C_1 = 46.7%; C of humic acids:C of fulvic acids = 1.8), b) the group and fractional composition is uniform throughout the profile, and c) the relative role of humins increases in the humus.

Table 1 (continuation)

Fraction I, extracted by 0.1 n NaOH			Frac. II being extr. by altern. processing of 0.1 n NaOH and 0.1 n H_2SO_4			Residue	Total C humus in fractions		C of humic acids	C of fulvic acids	C of humic acids / C of fulvic acids	C of fulvic acids / C of humins
C of humic acids	C of fulvic acids	C of humic acids / C of fulvic acids	C of humic acids	C of fulvic acids	C of humic acids / C of fulvic acids	From "g"	Fraction I C_1	Fraction II C_2				
36.1	16.0	2.2	6.5	2.8	2.3	33.8	52.1	9.3	42.6	18.8	2.3	1.2
31.3	19.0	1.6	5.7	3.1	1.8	29.6	50.3	8.8	37.0	22.1	1.6	1.2
15.1	21.8	0.7	5.7	3.4	1.7	46.2	36.9	9.1	20.8	25.2	0.8	0.6
32.7	13.3	2.3	7.0	2.8	2.4	32.8	46.5	9.8	39.7	16.6	2.3	1.2
34.4	14.8	2.1	4.7	3.4	1.3	36.2	49.2	8.1	39.1	18.2	2.1	1.3
36.3	17.5	2.1	2.1	3.2	0.6	39.5	53.8	5.3	38.4	20.7	1.9	0.9
40.0	13.9	2.8	5.2	2.7	1.9	32.3	53.9	7.9	45.2	16.6	2.7	1.1
47.5	17.8	2.6	3.5	2.6	1.3	28.5	65.3	6.1	51.0	20.4	2.5	1.7
19.3	20.0	0.9	8.7	5.1	1.7	41.5	39.3	13.8	28.0	25.0	1.1	0.6
40.0	15.3	2.6	10.7	2.8	3.8	31.4	55.3	13.5	50.7	18.1	2.8	1.4
37.5	18.7	2.0	3.4	2.6	1.3	37.2	49.2	6.0	40.9	21.3	2.0	1.0
16.1	21.7	0.8	8.7	4.4	2.0	46.5	37.8	13.1	24.8	26.1	0.9	0.5
24.0	18.3	1.3	12.5	10.2	1.2	30.2	42.3	22.7	36.5	28.4	1.3	1.2
23.2	16.3	1.4	13.4	11.5	1.2	33.3	39.5	24.9	36.6	27.8	1.3	1.1
23.0	13.0	1.7	22.9	7.1	3.2	27.2	36.0	29.8	45.7	20.2	2.3	1.7
22.2	13.6	1.7	20.9	7.2	2.9	34.1	35.8	28.1	43.1	20.9	2.0	1.2
30.5	16.2	1.9	7.1	4.4	1.6	37.2	46.7	11.5	37.6	20.6	1.8	1.0
30.0	18.4	1.6	6.8	2.5	2.7	34.8	48.4	9.3	36.8	20.9	1.7	1.0
29.0	19.0	1.5	7.5	3.4	2.2	33.6	48.0	10.8	36.4	22.4	1.6	1.1
29.0	26.0	1.1	7.3	5.0	1.5	30.0	55.0	12.3	36.3	31.0	1.1	1.2
25.6	22.8	1.1	6.1	5.0	1.2	33.5	48.4	11.1	31.7	27.8	1.1	0.9
42.1	16.8	2.5	5.9	3.4	1.7	31.6	58.9	9.3	48.0	20.2	2.3	1.5
20.9	29.4	0.7	6.3	5.7	1.0	34.0	50.3	12.0	27.2	35.1	0.8	0.8
21.3	36.4	0.6	7.4	6.8	1.0	25.6	57.6	14.2	28.7	43.1	0.6	1.1
37.2	15.3	2.1	2.5	2.4	—	40.0	52.5	4.9	39.7	17.7	2.1	1.0
19.3	13.7	1.4	1.4	1.3	—	54.0	33.0	2.7	20.7	15.0	1.4	0.4
21.8	14.6	1.4	1.6	1.0	—	57.6	36.4	2.6	23.4	15.6	1.5	0.4
39.0	15.4	2.5	0.0	0.0	—	35.9	54.4	0.0	39.0	15.4	2.5	1.0
42.4	15.5	2.8	0.0	0.0	—	32.2	57.9	0.0	42.4	15.5	2.7	1.3
—	—	—	—	—	—	—	—	—	—	—	—	—

In overall humus distribution along the profile, and in group and fractional composition, the Northern Azov and southern chernozems are intermediate. In content of the first fraction, quantity of humic acids and ratio of humic acids to humins, the Northern Azov chernozem is closer to ordinary chernozems, but in uniform profile distribution of these indexes, it is closer to the fore-Caucasus type. In content of humic acid of the first fraction, quantity of humins, and the ratio C of humic acids: C of fulvic acids in the upper horizon, the southern chernozems are closer to ordinary chernozems; in uniform ratio C of humic acids:C of fulvic acids, they are closer to the fore-Caucasus type. The southern chernozems also have their unique features. Relative content, in the humus, of first fraction humic acids, of humins, and the total easily-mobile humus materials increases in them with depth. These features are possibly connected with the soil-forming parent materials, i.e., with compact structural clays.

In comparing the humus materials in the Northern Azov chernozem from virgin areas and those long under cultivation with grain crops, one notes that in cultivated areas, the decomposition of organic matter proceeds more intensively than in the virgin areas, as shown by a decrease in organic matter content in cultivated areas by 9%-10%. Better moisture conditions of the cultivated area in May in combination with high temperature favor humification of vegetative residue with prevalence of humic acids in the humus. Drying of soil and rise in temperature in summer favor the relative increase, in humus, of humic acids both in the virgin and in the cultivated areas which in this period are close in humus composition.

Chestnut soils in upper horizons differ in
mus composition from chernozems by a
mewhat larger content of the fraction com-
ned with R_2O_3, by lower humin content and an
most complete lack of substances being ex-
acted during decalcination.

In group composition, the humus of chestnut
ils differs from chernozems in greater con-
nt of fulvic acids (the ratio C of humic acids:
of fulvic acids is in the limits of 1); only in
e upper horizon of the virgin chestnut soil
e the humic acids two to three times greater
an the fulvic acids. This ratio decreases to
8-0.6 in the lower horizons.

Humic solonetz has the same composition as
e zonal soils, differing only in a considerably
eater content of humins which increases with
pth, and in horizon B attains 57%; the frac-
on extracted during decalcination comprises
%.

The presence of exchangeable Na increases
e content of mobile fraction of humic substances and of fulvic acids in their composition. Exerting a dispersive effect on the clay minerals, it favors the increase in permanently combined fraction of humins.

Sod-meadow soil has 2 1/2 times more humic acids than fulvic acids. They are typified by high content of humins; the ratio C of humic acids:C of humins equals 1.

Conclusions

A study of the group and fractional compositions of the humus in provincial chernozems and chestnut soils of the Rostov region shows certain typical features, expressed chiefly in a considerable increase (in the chernozems) of the ratio of fulvic acids in comparison with chestnut soils.

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DETERMINATION OF IRRIGATION RATES

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Existing methods for determining the hydrophysical properties of soils (such as lysimeters — isolated columns, funnels), flooded plots, (with the aid of wiers, directly from a measuring container, or with the aid of portable devices), Kachinskiy's differential method, laboratory methods, etc. are based on the intake of water by flat soil areas of various sizes at a constant or variable head (1, 3, 5 and others). Such an intake differs from that which occurs during irrigation by filling along strips or furrows (production irrigation). The total characteristics obtained by these methods yield almost nothing for irrigation and therefore are of no use either in practical work of in the planning of irrigational areas. The available handbooks (2, 6, 14 and others) also do not help to solve the irrigation problems.

In the study of soils for irrigation purposes, especially in determining irrigation rates, the question of their water permeability arises first. To a greater degree than other physical properties, water permeability reacts to any affect being exerted on the soil; temporally it varies greatly with the same soil variant and in genetic layers (5). However, there are no bases for attaching great importance to these changes, especially from the practical viewpoint.

Under proper irrigation, there is first of all manifested the initial stage of the water permeability process, called intake rate. This was indicated as early as 1932 by Kostyakov (11). Intake rate occurs only from a specially prepared surface (plowland) and proceeds fairly quickly (we are discussing irrigated fields and not the conducting and irrigating network, where filtration is manifested to a greater degree). At high irrigation rates (800 m³/ha and more), even in fine-textured parent materials, the water intake rate in the soil occurs for very brief intervals. Therefore in determining the irrigation rates, there is no need to conduct many hours of observation to determine the CF (coefficient of filtration).

We noted dozens of cases of the initial int rates in the surface of various soils, deposit in various soil zones with a heterogeneous ve tation, having varying moisture contents, fra work, salinization, etc., and in plowlands. withstanding the great deviations, we noted a regularity of initial intake rate in the soil gr according to texture (Table 1).

Even the virgin fine clays did not manifes an initial intake rate of less than 500 m³/ha.

Considering that under proper irrigation, the processes of intake rates occur from the surface and at once over a great area of tille land (plowland), the effect of fortuitous facto (compaction and puddling of the surface, spr ing, dynamicity in time and variation accord to genetic layers, variations connected with structure and consistence of soil will be mar fested very weakly, especially since soil absorbs a great amount of water (600-1200 m³/ in a very short time.

These conditions compelled us to reexami not only the method of determining the hydro physical properties of soils (1, 6, 8, etc)., bu also to expand considerably the program wit view to solving many of the irrigation proble

As early as 1955, the Leningrad Water R lamation Institute began research in this are solving the problem of the compensation of earth being flooded by the reservoir of the Bukhtarmin Hydroelectrical Station in Easte Kazakhstan. With the chance of working und conditions resembling production ones, (the presence of an irrigation network and of wat permitting the conduct of self-flowing irriga on large scales), it was first necessary to d cide on work methods.

Turning to instructions and literature sou we found only a reference in a report by Kac skiy (8) to the effect that "...the most impr method will be a study of the water penetrati of soil by way of wetting test plots wherein t

Table 1

Average data on initial water intake rate into soil

Texture	Total intake in m³/ha in 1st hour of irrigation
Clays and fine silty clay loams	up to 800
Fine clay loams and medium silty clay loams	up to 1200
Medium clay loams, coarse clay loams and fine silty sandy loam	up to 1500 and more

ater is subjected to the same method as is roposed to be done during the irrigation of e territory." However, there is nothing in is method to indicate how these operations re conducted and how all the necessary indexes re measured.

Having become familiar with Kostyakov's 2) theory of irrigation by strips, we es- blished the actual regime of such an irriga- on on the basis of his studies, having therein verted main attention to measuring the water eing fed along the strips and taking it into ac- ount after its passage along the strips.

Experiments were conducted on the "Prav- a" (Truth) collective farm of the Zaysan dis- ict in the Eastern Kazakhstan region, lo- ted on the northern slope of the Saura-Tar- gataya rolling foothill plain. Here the parent aterials are the alluvial-deluvial medium d coarse clay loams, underlain at 50-80 cm pth with rubbly-gravelly deposits (Table 2). he soil is uniform, represented by light estnut-brown soils. Microrelief is lacking. ope of the locality is 0.025-0.007.

Irrigation was accomplished by specially pre- red strips, with width and length of 3 x 77 0) m, 3 x 100, 3 x 120 m. Measuring rates the irrigation water was conducted with iangular wiers at the beginning and end of e strip. Floodings were conducted with tes of 500, 600, 700, 900, 1,000 and 1,200 ³/ha in calculation by area of the strip. Ex- riments were conducted with varying dis- arges of an irrigation stream for finding the timal discharges (with the least waste) and a termination of erodibility. In each case, nount of discharge was constant during the tire time of the experiment (for reducing the rors).

In the delivery of water along a strip, we corded:

1. The time of running through a section of , 20 m, etc. and the beginning of waste. 2. eginning and end of intake from sections of , 20 m, etc. 3. Difference in volumes of ater having passed through both wiers is the actual water intake by the soil (average in cu/m in calculation per ha).

After 24 hours, trenches were dug in the upper and lower parts of the strip (perpendicular to it) in which the wetting contours were observed and the after-irrigation wetness was determined four times. Above the experimental strips, simultaneously with the flooding, control holes were dug for determining the pre-irrigation wetness of the soil; thus, after the floodings one could determine the amount of water taken in by the test strips. The rates figured according to the actual after-flooding moistness in cu m/ha according to samples taken, and the norms calculated in the same way according to indexes of the wiers, differed. Permissible deviations were observed in tests with computational rates of 700 and 900 cu m/ha (Tables 3, 4).

Unavoidable deviations were observed:

1. At high rates (strip 2), when losses into the gravelly deposits increased; 2. At small discharges of the irrigation flow before the water has flowed to the end of the strip and is fully absorbed by it (strip 3); 3. At high discharges when a large part of the rate has been lost to waste (strip 4); 4. In long strips where the water is fully taken in by the soil, not reaching the end of the strip (strip 1).

Table 4 shows that moisture in the plots corresponded to rates of 546.5 (strip 5) and 811.4 cu m/ha (strip 6), which correlates well with the actual amount of water delivered.

The studies performed by the Leningrad Water Reclamation Institute show the possibility of conducting investigations by way of a field modelling of irrigation strips. No special or complex equipment is needed for such studies. Practice shows that it is convenient to irrigate from a gas tank truck which, with prepared strips or furrows, floods them in one or two days. For several years the Leningrad Institute has been using gas truck transports not only in regular irrigation areas, but also in estuary areas. For storing water, other three to five ton containers can also be used but this is less

Table 2

Data of particle-size analyses

Profile No.	Depth, cm	Loss from processing	Particles in % for absolutely dry soil												
			> 7.0	7.0—5.0	5.0—3.0	3.0—2.0	2.0—1.0	1.0—0.5	0.5—0.25	0.25—0.05	0.05—0.01	0.01—0.005	0.005—0.001	< 0.001	Total par. <0.01 in dia. with corr. for proc. loss
22	0—8	4,5	0.8	0,6	1,6	1,4	2,2	Traces	2,4	24,5	26,8	13,5	13,9	7,8	36,6
	18—28	4,1	3,3	0,6	1,3	1.0	2,7	5,8	3,8	10,8	32,2	10,0	13,8	10,6	35,7
	45—55	7,0	0.8	3,1	6,5	4,5	7,2	2,7	4,9	31,0	13,0	11,9	3,7	3,6	26,2
	65—75	6,1	22.8	4,0	7,9	4,2	6,1	6,5	10,8	14,6	8,5	2.8	1,8	1,9	8,9
	100—110	0,9	69,3	6,4	7,0	3,0	3,6	0,2	0,3	7,3	1,7	0,5	0,2	0,6	1,4
	125—135	1,6	47,9	10,8	7,8	5,6	8,5	1,9	1,9	11,7	1,7	0,1	0,08	0,03	0,5
21	0—10	4,6	3,2	1,4	2,8	1,7	3,3	None		30,6	19,6	11,2	14,9	6,6	34,0
	18—28	6,0	7.2	2,8	5,1	3,6	6,8	1,8	1,9	28,0	18,6	5,2	7.8	5,1	24,1
	45—55	7,9	11,9	3,1	6,4	4,5	6,8	2,5	5,1	26,3	13,8	4,9	2,1	4,7	19,6
	60—70	7,8	31,1	3,7	6,8	4,2	7,3	1,5	1,5	22,5	7,4	0,7	2,3	3,3	6,7
	75—85	7,7	37,6	3,7	5,7	3,1	5,8	2,5	5,5	13,9	7,5	1,9	1,5	3,6	7,6
	110—120	1,8	46,9	8,9	7,7	5,2	7,4	3,2	4,6	9,7	1,9	0,8	0.3	1,4	2,6
	150—160	2,3	39,2	6,8	11,11	6,1	9,5	2,8	5,9	12,9	1,4	0,4	1,0	0,5	1,9

Table 3

Experimental data

	Strip 5	Strip 6
Assigned values		
Irrigation rate	600 m^3/ha	900 m^3/ha
Discharge at the upper spillway	19.7 liter/sec	16.6 liter/sec
Length of strip	77 m	77 m
Width of strip	3.4 m	3.4 m
Area of strip	262 m^2	262 m^2
Amount of water fed to strip without figuring waste	18,340 liters (18.3 m^3)	23,480 liters (235 m^3)
Duration of adding water to strip without figuring waste	15 min: 31 sec	23 min: 40 sec
Experimental operations		
Start of delivering water into strip	14 hr: 34 min	14 hr: 43 min
End of delivering water into strip	14 hr: 49 min: 30 sec	15 hr: 09 min: 40 sec
Flowing time of water from start of irrigation, 10 m	14 hr: 35 min	14 hr: 45 min
20 m	:36 min	:47 min
30 m	:37 min	:49 min
40 m	:39 min	:52 min
50 m	40 min: 40 sec	54 min: 30 sec
60 m	:42 min	:57 min
70 m	:44 min	
of entire strip	14 hr: 45 min: 30 sec	15 hr: 02 min
Duration of flow	11 min: 30 sec	:19 min
Start of water loss (waste) from strip	14 hr: 45 min: 30 sec	15 hr: 02 min
Waste and intake of water after stopping delivery to strip beginning	14 hr: 50 min	15 hr: 11 sec
—10 m	14 hr: 51 min	15 hr: 2 min: 30 sec
—20 m	14 hr: 52 min: 30 sec	15 hr: 14 min: 30 sec
—30 m	14 hr: 55 sec	15 hr: 15 min: 30 sec
—40 m	Water was absorbed	

onvenient. Besides this equipment, a 200 iter tank with a system of cocks for regulating ie water delivery is needed. For this, in the ower part of the tank, no higher than 5 cm rom its bottom, it is necessary to weld in ater-measuring nozzles (Fig. 1; Table 5), o regulate the water flow.

The water discharge is figured at constant ead of 1 m. Therefore a mark is made in ie tank at 1 m height. During operations, ie change in the level should not exceed 10 m on either side. In addition, one needs a 00 liter tank (a cut-off half of a 200 liter one) ith a graduated scale in liters and 23-30 iron lates (1.5 x 1000 x 200 mm) used in place of ollers, for grooving out the model strips.

With models, special attention should be aid to the time the water is in the strip beause this is the primary factor determining ie amount of water intake. This time should be etermined only at an efficient discharge of ater which assures the maximum intake with the least waste.

The essence of model consists in releasing water with a definite discharge from an upper reservoir onto an inclined area of definite length, width and slope and, having collected the runoff water in a lower measuring reservoir (in filling the lower reservoir, it is necessary to pour back the water with measuring buckets into the upper reservoir), one determines the amount of water absorbed by the soil.

It is feasible to find the irrigation rates from graphs of the relation (of amount of water absorbed) to time (15, 30 sec, etc. at fixed and constant q = specific discharge).

In practice, it is recommended to take the first characteristics from areas 1 x 10 m, at q = 0.6-0.7 liter/sec; wetting depth is recorded simultaneously with electric needles (Fig. 2) so that it is always possible to correct the wetting depth with the rates. A soil-material

Table 4

Soil moisture data in plots

Depth, cm	Bulk density (BD)	Experimental strip 5. Irrigation rate 600 m³/ha					Experimental strip 6. Irrigation rate 850 m³/ha				
		Natural moisture		Moisture after irrigation		Addit. moist. from irrigation mm	Natural moisture		Moisture after irrigation		Addit. moist. from irrigation mm
		In %	In mm	In %	In mm		In %	In mm	In %	In mm	
0—10	1.24	1.05	1.33	14.24	17.61	16.28	1.05	11.33	17.49	21.69	20.36
10—20	1.35	4.10	5.53	14.17	19.16	13.63	4.10	5.53	17.80	23.03	18.50
20—30	1.44	6.30	9.07	12.63	18.12	9.05	6.30	9.07	17.03	24.52	15.45
30—40	1.34	7.62	10.25	11.99	16.06	5.81	7.62	10.25	14.26	19.15	8.90
40—50	1.44	7.80	11.32	8.66	12.48	1.16	7.80	11.32	12.46	18.00	6.68
50—60	1.51	4.90	7.39	6.66	10.05	2.66	4.90	7.39	10.00	15.10	7.71
60—70	1.56	2.10	3.27	5.98	9.33	6.06	2.10	3.27	5.02	7.84	4.57
Moisture in layer											
0—70			48.16		102.81	54.64		48.16		129.30	81.14[a]

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[a] Insufficiency of moisture (not conforming with the supplied rate) can be explained by the slight wetting of the upper part of gravel layers from which samples were not taken, and by the slight spreading of water beyond the area's limits.

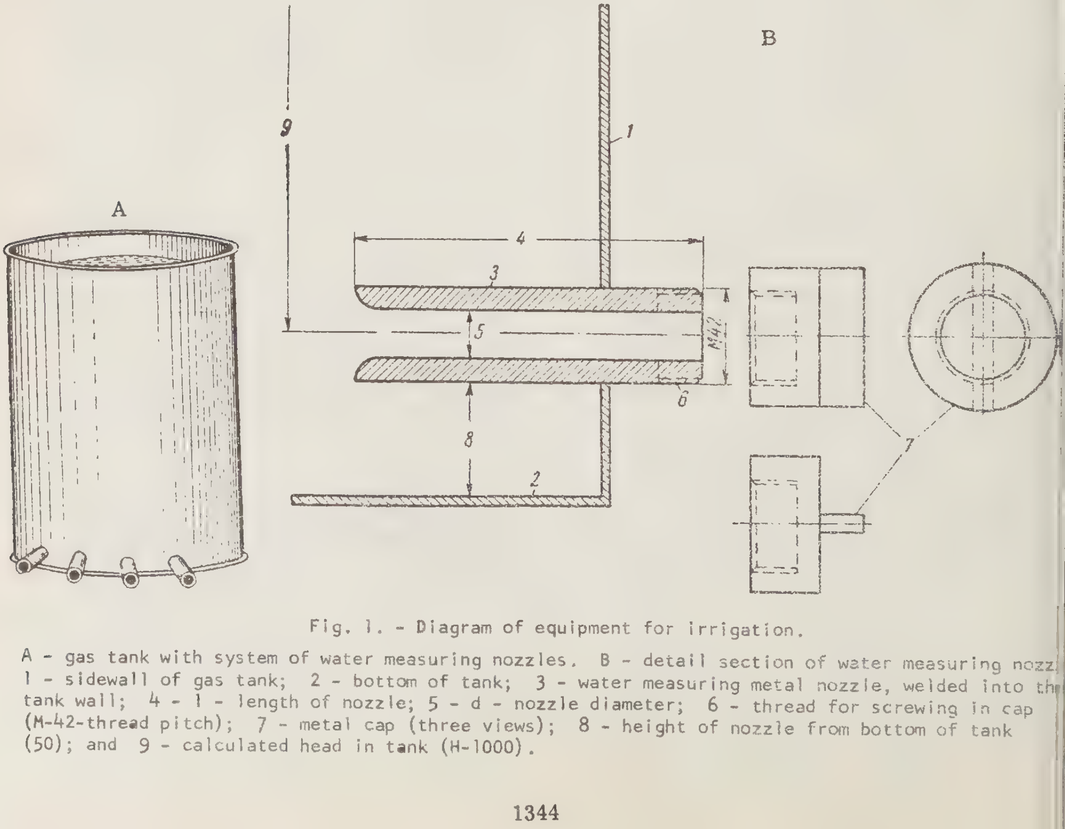

Fig. 1. - Diagram of equipment for irrigation.

A - gas tank with system of water measuring nozzles. B - detail section of water measuring nozz 1 - sidewall of gas tank; 2 - bottom of tank; 3 - water measuring metal nozzle, welded into th tank wall; 4 - l - length of nozzle; 5 - d - nozzle diameter; 6 - thread for screwing in cap (M-42-thread pitch); 7 - metal cap (three views); 8 - height of nozzle from bottom of tank (50); and 9 - calculated head in tank (H-1000).

Table 5

Dependence of diameter and length of water-measuring nozzles upon water discharge

Q-discharge, liters/sec	D-diameter of nozzle, cm	1-nozzle length, cm	Q-discharge, liters/sec	D-diameter of nozzle, cm	1-nozzle length, cm
0.5	1.4	2.8—4.2	0.8	1.8	3.6—5.4
0.6	1.6	3.2—4.8	0.9	1.9	3.8—5.7
0.7	1.7	3.4—5.1	1.0	2.0	4.0—6.0

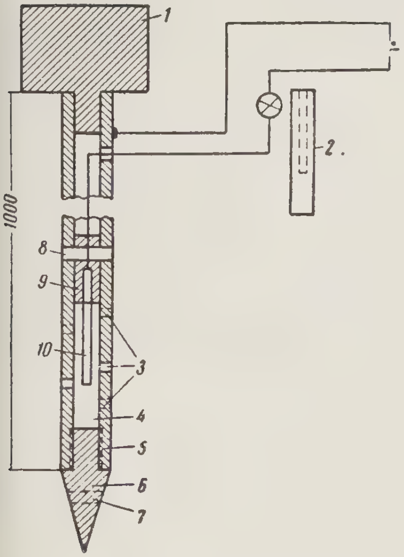

Fig. 2. - Schematic drawing of soil electric needle.

1 - head for driving needle into ground: 2 - cylinder made of pumice; 3 - orifice for penetration of water into needle (d = 10 mm); 4 - pumice cylinder (soaked in supersaturated HCl solution and dried at 105°C); 5 - tube. ID = 3 mm, OD = 6 mm. GOST (State Std) 301-50. Length up to 800 mm; 6 - steel tip, screwed into the tube; 7 - opening in tip for insertion of metal rod for screwing the tip off and on; 8 - cotterpin for holding ebonite plug; 9 - ebonite plug; 10 - brass rod.

ectric needle is driven into the center of the
rip for depth of 50-80 cm. Upon reaching
e depth of water intake, a small bulb lights
. Upon finishing the work, the needle has
be pulled out, the steel tip is screwed out,
d the wet cylinder is removed. The needle
dried and a new cylinder is inserted for the
xt test.

In the calculation of rates for the production strips, it will be possible to allow errors. Their development, i.e., the finding of conversion coefficients, is the further stage of experimental studies.

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ETERMINING MOVEMENT RATE OF A WETTING FROST

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The movement rate of a wetting front along soil profile is of great practical and scien- fic interest, notably in regions of artificially ontrolled water conditions. No widely known ethod has been evolved for its determination. he soil moisture-meter (inventor K. N. Shish- ov) built by the All-Union Scientific Research stitute of Hydro-Engineering and Land Rec- mation (VNIIGiM) is used for determining the ovement rate of a wetting front but the un- ieldiness of the devices and the need for quipping each device with a vacuum gage re- rds their wide introduction.

We propose here a simplified device for de- rmining the rate of movement of a wetting ont and the wetting depth of the soil whose perating principle, as that of the VNIIGiM oisture-meter, is based on the relation be- veen the soil's suction force and its moisture.

The device consists of the following basic arts: 1 — a ceramic filter with pores 1-1.5 icrons in diameter (as in the VNIIGiM de- ce); 2 — a rubber connecting vacuum tube; — a glass tube (ID 5-10 mm). The tube ngth is set by the depth of installing the de- ce, plus 40 cm (length of the scale above the oil surface); 4 — rubber stopper; and 5 — a ooden detachable case, opening in its upper rt, opposite the scale (hinged lid).

The assembled device (Fig. 1) is partly lled with distilled water (boiled to remove r); between the bottom of the stopper and ater level (meniscus) an air column 30-50 m high (air cushion) is left in the glass tube. t drop in water level in the glass tube (by suc- on through the filter or drying), the remain- g air expands and pressure drops.

Proceeding from the Boyle-Mariott law, essure in tube at drop in water level is mputed by the formula:

$$P = \frac{v_0}{v} \times P_0 \text{ mm of Hg column,}$$

here P_0 and v_0 = air pressure and volume in tube at filling of devices; P and v are air pressure and volume at any given moment.

In our case, since the cross section of the glass tube is constant throughout its length, we can write:

$$P = \frac{h_0}{h} \times P_0 \text{ mm of Hg column,}$$

where h_0 is initial height of air column (30-50 mm); P_0 = atmospheric pressure (760 mm of Hg col.); h = height of air column in mm at moment of observations; and P = pressure in tube at moment of observations.

At an arbitrary moment, vacuum in the device will equal difference between atmospheric pressure (P_0) and tube pressure (P).[1]

For investigating movement rate of wetting front in soil profile, prior to setting up device in the soil, a vacuum is developed of about 0.8 atm in the device. At h_0 = 30 mm, such a vacuum is achieved by lowering the water level (meniscus) in a glass tube of any diameter to a 150 mm reading on the scale (cf. drawing), and at h_0 = 50 mm, to a 250 mm reading (lower level of the rubber stopper should be inserted at zero on the scale in the tube).

Setting the level at the initial reading (30-50 mm) is accomplished with a loading needle inserted between the stopper and the tube's inner wall. In loading, water is poured into the device up to a reading of 15-20 mm. The tube is covered with the stopper equipped with a loading needle. Owing to gravity, the water passes through the filter, its level drops in the glass tube and air enters a slot in the needle. Upon setting the meniscus opposite the reading of 30 and 50 mm, the needle is removed and the air column in the tube is disconnected from the

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[1] Vacuum calculation is simplified: variations in atmospheric pressure and temperature at time of loading the device and during observations are disregarded.

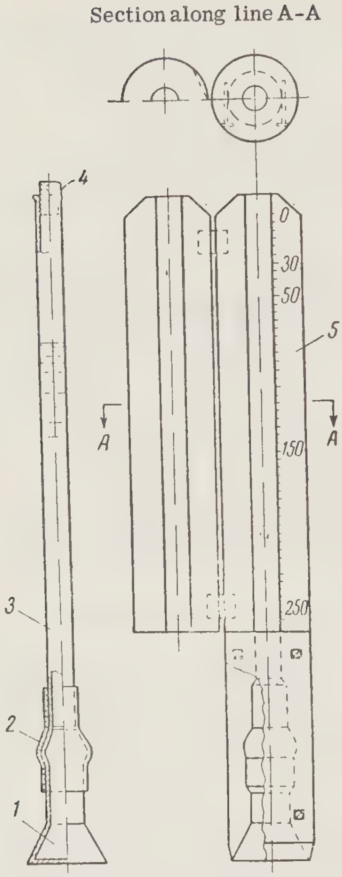

Diagram of device for measuring the rate of movement of wetting front.

atmospheric air. For developing vacuum in the device, a further lowering of the water level should be done directly before the test by pumping water through the filter, since in drying the devices, in two or three days, air enters through the filter, and at the same readings, vacuum will be less.

After preparing the devices, they are set in holes in an area being studied, at those depths for which the passage time (from start of test) by a wetting front is of interest to the researcher. Diameter of the wooden case should match that of the hole, so that with little effort the device can be pressed into the entire depth of the hole. Twisting the device while pressing it downward (upon reaching the bottom of the hole) assures good contact between soil and filter.

In studying the movement rate of a wetting front at points located every 20 cm and more according to soil profile depth, one can work with one device in several previously prepared holes, by installing it successively (after beg ning in drop of level) from shallower to deep holes.

According to outer form of area, holes ar so bored at an angle to the vertical that the soil structure is not disrupted and filters are inserted to the depths being investigated. Up wetting the soil, because of the device's vacuum, water enters through the filter, its leve rises in the glass tube and the readings drop. The drop in the device's readings understandably begins only when water penetrates to the depth of the device's installation. The upper limit of the initial soil moistness (before testing) at which use may be of the proposed device for ordinary chernozem comprised 25%-26% in our tests (marginal field water capacity 32%).

In studies of movement of a wetting front in moist soil (20%-26%) during the time from flooding the area up to water penetration to t filter's level, a slight decline (of 1-3 mm) i device's readings takes place due to the devices' pumping moisture from the soil. But a rapid, easily visible drop in readings begi when the infiltrating water reaches the filter. On installing the devices in dry soil, the rea ings drop by 1-3 mm.

Since one needs to observe the readings constantly during the test, these slight increases in the level do not decrease the accuracy of fixing the start in the rapid decline in readings, i. e., the time that the infiltrati water appears at the filter's level.

The mean movement rate of the wetting fr is easily figured from the time of starting th test to the start in drop of readings, and fro the depth from soil surface to bottom of filte

Table 1 shows the results of research on movement rate of a wetting front in one of th tests conducted on the Voronezh SKHI "Otra noye" Experimental Farm.

From these data, it is apparent that movement rate of a wetting front decreases in proportion to increase in wetting depth. If in th 0-20 cm layer, this rate was 1.18 cm/min, in the 50-90 cm layer, it is only 0.6 cm/mi Test holes showed a good correlation of data obtained by the device with the actual wettin boundary (visible outline of wetting was only 0.5-2 cm below the bottom of the filter).

Simplification of the devices and removal the need for equipping them with a special fi for measuring vacuum, plus their compactn and ease of manufacture, makes their exten use in similar investigations possible.

Table 1

Rate of movement of wetting front in ordinary chernozem

Device No.	Depth installed, cm	Device reading in mm prior to start of test	Time in min from start of test to start of drop in readings on the device	Rate of movement of wetting front, cm/min	Amount of absorbed water from start of test to start in drop of devices' readings, mm
1	20	165	17	1.18	79
2	50	173	48	0.97	159.4
3	90	136	115	0.16	306

Conclusions

1. A method has been developed and a simple evice is suggested for determining movement ate of a wetting front based on soil's suction rce.

2. The method's advantage consists in its making possible the measurement of this rate under field conditions, coupled with simplicity and rapidity of conducting the investigations.

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DIAGNOSTICS OF SPRING WHEAT NEEDS FOR NITROGEN AND PHOSPHORUS BY MEANS OF TOTAL CHEMICAL ANALYSIS OF LEAVES DURING THE FLOWERING PERIOD

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The great possibilities of diagnosing plant needs for fertilizers by means of total or leaf analysis have been noted in a number of papers (6, 8, 9, 13-15, 18, 19, 25, 29). Methods of analysis, devised by Davtyan (6), Magnitskiy (15), Tserling (26) and others, make it possible to determine quickly these needs directly in the field. However, since such methods rely primarily on a nitrate content in the top of leaves and stems, they can be used only during the early phases of plant growth. But for practical agricultural objectives it is essential to be able to determine how the plants are provided with nitrogen during their flowering and ear-forming period. A number of studies (10, 17, 20, 30, 35) recommend the application of a nitrogen during this period in order to increase the protein content of wheat. This method has been extensively used in East Germany, Hungary and other European countries (1, 10, 30).

To be able to use a differential method of nitrogen application during the flowering period, it is necessary to determine what percentage of it could be expected to be contained in the wheat grain under present conditions. In other words, it is necessary to be able to make a sufficiently accurate, for practical purposes, prognosis of the quality of grain before deciding the question of the late nitrogen application.

During the recent years the importance of knowing the total content of nitrogen, phosphorus and potassium in the leaves of many crops during their flowering period, in particular for the purpose of determining their nutritional requirements has been widely recognized (18, 19). Studies of the correlation between the chemical composition of leaves (15, 18, 19, 31, 34, 36-38) and the yield led to the establishment of "critical" nutrient levels for certain crops (2-5, 18, 33).

The correlation of this kind for spring wheat has not received much attention and the published works do not offer any data pertaining to its "critical" nutrient levels (15). We know only of one paper by Levitskiy and Lesyukova (13) which outlines "critical" leaves for spring wheat and oats on the basis of a chemical analysis of th whole plant. The use of leaf analysis for determining nutrition needs is barred by the lac of appropriate data.

This report offers the results of the use o leaf analysis in determining the differential n trogen application during the flowering perio and the need for nitrogen and phosphorous fe tilizers during the following years.

Operational methods. It was decided to m the estimates of plant nutrient requirements and quality of wheat grain during the flowerin setting phase.[1] The choice of time was deter mined by certain special characteristics of tl phase which have been noted in earlier works (2, 4). Field experiments were conducted on normal medium-sandy loam and clay loam ch nozems of the Korov's Omsk Agricultural Institute from 1954 to 1957, and of the sovkhoz "Elita," Moskalenskiy district, Omsk region in 1957. Before the seeding, soil samples were analyzed to determine the content of available nutrients: N, NO_3, P_2O_5 (Truog's method) and K_2O (Brovkina's method). A mo detailed chemical soil analysis was also mad The following kinds of spring wheat were use Mil'turum 553, Gordeiforme 10, Lyutestsens 62, and Lyutestsens 758. The selection of plant samples was made during the flowering period, 6-8 days after the ears had been com pletely formed. Three samples of 100-150 plants each were taken at random from each uniform soil plot or from each variation of tl experiment. After that an average sample w composited. To prevent the pollution of leav by dirt, the selected plants were cut 10-15 c above the ground. Since the lower leaves we by that time usually dried up, they were not cluded in the samples. To preserve the pla they were treated by the steam of boiling wat for 20 minutes prior to the removal of leave hich were then air-dried. The first four pper, and biologically most active, leaves ere used for the analysis (7, 12). The analysis leaves and grain to determine the total nitro- en was conducted by Kjeldahl's method with vo-to-three replicates. The content of P_2O_5 determined by means of wet ashing of the ubstance by sulfuric acid with 30% of added erohydrol, free of P_2O_5 (25). The following stimations of P_2O_5 in the extract were made by olorimetric method of Kjeldahl and Khrenova.

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[1] The flowering period — setting — is the initial phase of the grain forming, after fertilization.

The field experiments were conducted on 00-160 m² plots with three replicates. The ield was estimated on the basis of the total rashed harvest from each plot. In 1957, ten est areas (5.25 m²) were used for each repli- ate. After that the harvest data were proc- ssed and the degree of accuracy of the experi- ients was calculated.

Containers each holding 5.5 kg of completely ry soil were used for the pot experiments. The oil came from the experimental plots, and pots ere replicated three times. Fifty mg of N and $_2O_5$, and 100 mg of K_2O per 1 kg of completely ry soil was applied before filling the pots. uring some treatments of field and pot experi- ients the amount of nitrogen and phosphorous cid was increased by several times. In this ay it was possible to make rough estimates of ie "critical level" of nutrients for spring wheat regard to these elements. During the experi- ients the soil moisture was expressed in the ollowing percentages of the total moisture ca- acity; in 1955, 80%; in 1956, 60%; in 1957, 0% and 80%.

In each container 32 germinated seeds were lanted. After the appearance of the third leaf, nly 15 plants were left to grow further. Three them were cut during the flowering period nd the appropriate leaves of their main shoots ere analyzed. On the basis of the data re- eived, it was possible then to make a program the quality of the grain and to apply, if neces- ary, nitrogen either by root or outside of the oot.

Investigation results. The correlation be- een the contents of nitrogen in the leaves uring the flowering period and in the mature rain as an indicator of plants' requirements in late nitrogen application.

A direct correlation between percentages of itrogen content in the leaves during the flower- g period and in the mature grain has been es- blished (2-4). A method suggested in Kondrat'- eva's work (11) was used to graphically express is correlation and to determine its coefficient) and the regression equation. This is shown Figure 1.

As can be seen in Figure 1, the coefficient of is direct correlation is very high (R = 0.93 ± 0.01). Our experiments provided data for expressing this correlation by the following equation:

$Y = 0.85X + 0.27$. "Y" stands for the expected percentage of nitrogen in the mature grain; "X" — for the percentage of total nitrogen content in the leaves during the flowering phase; "E" (Fig. 1) presents the possible error margin in making prognosis of the nitrogen content in the mature grain; it amounts to ±0.20. By using this equation or the coefficients which have been formulated earlier (2 and 4), it is possible to make one month ahead of harvesting, a sufficiently accurate prognosis of the nitrogen content in the grain and to decide whether the late nitrogen application is necessary. The pot experiments, which we conducted in 1957 with two kinds of apring wheat under different soil moisture conditions in containers, confirmed the previously mentioned conclusion. The results of these experiments are given in Tables 1 and 2. The $N_{20}P_{50}K_{100}$ treatment of the experiment had 12 replications. After taking leaves for an analysis during the flowering period, three of the containers were left for future comparison, while the rest of them received, starting with the next day, a triple nitrogen application. The nutrient was provided every other day in the amount of 50 ml of solution per containers, by the root and non-root applications. The latter was done either without isolating (A), or with isolating (B) the soil. Lyutestsens 62 received one application of 0.9% solution of NH_4NO_3 and two applications of 0.7% of urea. Gordeiforme 10 received only urea. Tables 1 and 2 show that when plants are sufficiently provided with phosphorus and potassium (this can be established by analyzing the soil, plant leaves and their responsiveness to fertilizers), there is a direct connection between the content of nitrogen in the leaves and the size of yield and also between the content of nitrogen in the leaves and in the mature grain. The coefficient of the correlations among these factors may be very high (0.94).

Under the conditions of the optimium soil moisture (60%) an increase in the nitrogen applied produces a sharp increase in yield. It also produces an increase of protein and non-protein nitrogen in the leaves and, accordingly, leads to a higher percentage of nitrogen in the mature wheat grain. Experimental treatments without nitrogen resulted in achieving a high percentage of protein at the expense of the quantitative yield. An increase of soil moisture caused a decrease of nitrogen in the leaves which led to a decline in quality of grain of two kinds of wheat under observation (4). These data confirmed the interrelation between the accumulation of nitrogen in the upper leaves around the time of flowering-setting and the nutrition conditions, on the one hand, and the content of nitrogen in the leaves and the mature grain, on the other.

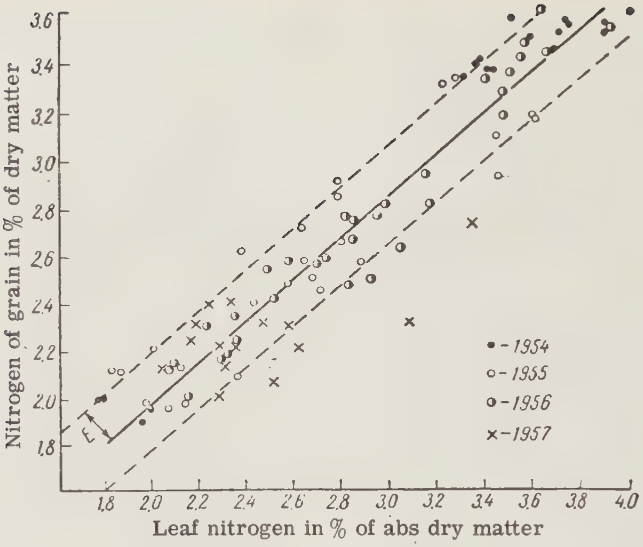

Fig. 1. - Relation between nitrogen content in the leaves during the flowering period and in the mature grain of spring wheat.

Table 1

Effect of fertilizers, soil moisture, and late application of nitrogen fertilizers on nitrogen content in the leaver and grain of Lyutestsens 62

Experimental variant	Grain yield in g per pot	Leaf content at end of flowering, %		Total nitrogen in the grain, %		Grain protein, %
		Total nitrogen	P_2O_5	Predicted	Actual	
Soil moisture 60% of full moisture capacity						
Without fertilizer	3.27	2.15	0.400	>2.50	2.74	14.3
$P_{50}K_{100}$	3.13	2.17	0.794	>2.50	2.83	15.0
$N_{50}P_{50}K_{100}$	8.51	2.59	0.579	2.49	2.30	12.1
$N_{100}P_{50}K_{100}$	12.12	3.36	0.517	3.22	2.72	14.4
$N_{20}P_{50}K_{100}$	4.92	2.35	0.632	2.26	2.41	13.0
$N_{20}P_{50}K_{100}+N_{80}$ non-root appl. (A)	5.0			—	3.33	18.2
$N_{20}P_{50}K_{100}+N_{80}$ " " " (B)	5.50			—	3.20	17.4
$N_{20}P_{50}K_{100}+N_{80}$ " " "	5.29			—	3.80	20.9
Soil moisture 80% of full moisture-capacity						
Without fertilizer	3.26	2.02	0.636	>2.50	2,56	13.6
$P_{50}K_{100}$	3.25	2.08	0.655	>2.50	2.75	14.6
$N_{50}P_{50}K_{100}$	6.81	2.06	0.588	2.06	2.13	11.1
$N_{100}P_{50}K_{100}$	10.71	2.48	0.456	2.38	2.31	12.2
$N_{20}P_{50}K_{100}$	4.64	2.20	0.600	2.20	2.31	12.5
Same $+ N_{80}$ non-root appl.	4.30			—	3.44	18.1
Same $+ N_{80}$ " " "	4.19			—	3.42	18.6
Same $+ N_{80}$ " " "	4.22			—	3.85	20.7

Note: Subscripts with chemical element symbols express amounts of nutrients, in mg/per kg of absolutely dry soil.

Table 2

Effects of fertilizers, soil moisture and application of area at the end of flowering on nitrogen content in the leaves and grain of gordeiforme 10.

Experimental variant	Soil moisture 60%				Soil moisture 80%			
	Grain yield g per pot	Leaf nitrogen %	Grain nitrogen, in %		Grain yield g per pot	Leaf nitrogen %	Grain nitrogen in %	
			Predicted	Actual			Predicted	Actual
Without fertilizers	4.49	2.32	2.16	2.13	3.90	2.26	2.26	2.39
$P_{50}K_{100}$	4.32	2.36	2.19	2.22	4.46	2.30	2.30	2.22
$N_{50}P_{50}K_{100}$	9.44	2.53	2.35	2.06	7.75	2.16	2.16	1.99
$N_{100}P_{50}K_{100}$	13.81	3.10	2.88	2.31	9.77	2.29	2.29	2.00
$N_{50}P_{50}K_{100}$	6.32	2.63	2.44	2.21	5.18	2.17	2.17	2.24
Same + N_{80} non-root ap-appl. (A)	6.88		—	2.66	5.85	2.17	—	2.79
Same + N_{80} " " " (B)	6.96		—	2.46	eliminated from the experiment			
Same + N_{80} root applica.	6.40		—	3.19	4.89	2.17	—	3.08

Note: We have established that the conversion coefficient for leaf nitrogen vs grain nitrogen in gordeiforme 10 is 0.93. When the leaves contain between 2.0 and 2.30% nitrogen, this coefficient is 1.0.

While studying the problems of nitrogen nu- ·ition, D. N. Pryanishnikov stressed the fact ıat there is a close interconnection between onditions of nutrition and the internal proc- sses of plant metabolism (23, p. 454).

As our experiments have deomonstrated, to ıow the interrelation of the content of nitrogen ı the leaves, the conditions of nutrition and the ontent of nitrogen in the ripe wheat grain — ıeans to know how to make an accurate prog- osis of the grain quality and to be able to in- ervene, if necessary, into the process of its ormation. Thus, the use of the late NH_4NO_3 ıd urea application (Table 1), or the urea ap- lication alone (Table 2), at the end of the flow- ring period assured a sharp increase in the rotein content of wheat. This method, as has een shown by other studies (20, 30, 35) is inex- ensive and, apparantely, economical (1, 10).

It should be noted that our coefficients (2-4) r mathematical expression of the previously scussed nitrogen correlation, were arrived on the basis of experiments with chernozem ıd under the conditions of sufficient supply of ıosphorus and potassium, or of varying, but ose to "critical," levels of nitrogen and ıosphorous nutrition. Therefore, our co- ficients would have to be checked and ad- sted, if they are to be used under different oil-climatic conditions. In doing so, it would e necessary to consider special characteris- cs of different crops, conditions of growth ıd development, harvest prospects, and the ontent of phosphorus, potassium and nitrogen in the leaves.

The coefficients for the change of nitrogen from leaves to ripe grain were different for early and late maturing crops. Thus, for Lyutestsens 62 the coefficient was 0.96, Gordeiforme 10-0.93, and for Mil'turum 553, it was 0.90. The size of the coefficient depends on biological properties related to the degree of intensity of the synthesis and hydrolysis of proteins in the leaves during the flowering period. According to Mosolov (16), in the leaves of late-maturing variety the protein synthesis prevails during this period over their hydrolysis. Hence, the flow of nitrogen to the spike is inhibited, its content in the leaves increases, and the coefficient for the change of nitrogen from leaves to ripe again in low, as compared to that of early-maturing varieties. It may be concluded that the conditions of nutrition, which promote the synthesis, have a lowering effect on the coefficient of the change of nitrogen (Table 4).

When the plants are provided with an adequate nutrition, the balance between the synthesis and hydrolysis of proteins in the leaves of early-maturing varieties is such that the coefficient reaches 0.96, i. e., it approaches 1. When nitrogen is in a short supply, the hydrolysis is more intensive, the plant ages quicker, and the flow of nitrogen from the leaves to the spikes begins and moves at a faster rate. This may cause a change — in time or in ratio — of the correlation between nitrogen content in the leaves and in the grain.

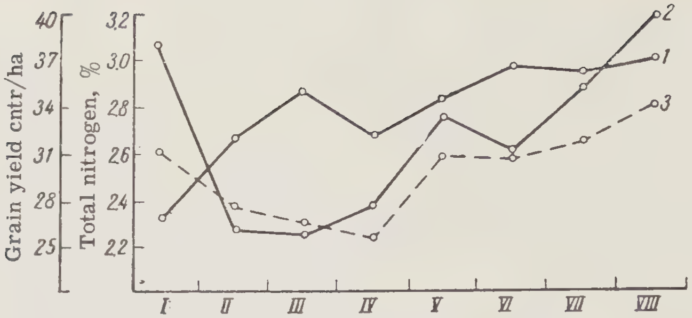

Fig. 2. - Effect of fertilizers on yield and nitrogen content in leaves and grain of Mil'turum 553 spring wheat in 1956.

1 - yield; 2 - leaf nitrogen; 3 - grain nitrogen; I - control; II - 10 tons manure + P_{60}; III - 20 tons manure + P_{60}; IV - $N_{30}P_{60}K_{30}$; V - $N_{60}P_{60}K_{30}$; VI - 10 tons manure + $N_{60}P_{60}K_{30}$; VII - 20 tons manure + $N_{60}P_{60}K_{30}$; VIII - 20 tons manure + $N_{60}P_{60}K_{30}$.

A 1.8%-2.3% content of nitrogen in the leaves during the flowering period may signify either a very serious, or relatively small nitrogen deficiency. The determining factors here would be the intensity of growth and development of plants and the quantitative prospects for harvest. When the moisture is sufficient and the plants receive only small amounts of nitrogen fertilizers, their growth is intensive and leads to the utilization of almost all accumulated nitrogen. Thus, the plants may be short of nitrogen already at the beginning of the spike forming period. This has an effect on the content of nitrogen in the upper leaves and, subsequently on the quality of harvest (2, 4). The foregoing described phenomenon was noted by Petrov (21) and confirmed by our pot (Tables 1 and 2) and field experiments (Fig. 2, treatments 2-4).

When the yields of an early or late maturing variety promises to be average (15 c/ha) or large (25-35 c/ha) and the content of nitrogen in the leaves is low (below 2.3%), the coefficient of the nitrogen change is expressed by 1.0. In order to obtain a high protein content in the grain, it is, however, still necessary to use non-root nitrogen fertilization during the flowering period.

A different situation is observed when the plants are deficient in nitrogen with the very initial phases of their growth and development (Table 1, treatments, 1, 2, and Table 3); little nitrogen occurs in their leaves during the tillering phase (3); growth processes are depressed; length and width of leaf blades is small; and leaves are of pale green color and form an acute angle with the shoot. When the visual symptoms of nitrogen deficiency coincide with a low percentage of nitrogen in the leaves during the flowering period and with prospects for a poor yield, it becomes very difficult to make an accurate prognosis of the grain quality. In suc
a case we observed in 1955 that the coefficie
of nitrogen content in the leaves and in the ri
grain approached 1.0 already during an earli
phase of plant development (Table 3).

When a crop receives too much nitrogen
(more than 3.1% of N in its leaves) and too li
phosphorus (less than 0.52% of P_2O_5 in its lea
the synthesis in its leaves is intensified and t
flow of nitrogen to its spikes is slower. Thi
may lead to a decrease in quantity and quality
the yields. Under such conditions, the coeffi
ent of nitrogen transformation from the leave
to the grain of Mil'turum 553 decreased from
0.09 to 0.75 (Table 4).

Thus, in making a more accurate prognos
of the quality of wheat grain, it is necessary
consider the following factors: special biolo
cal properties of the species conditions of its
growth and development before reaching the
flowering period, prospects for yields during
the flowering period, and condition of plant
nutrification. A prognosis based on the previously mentioned equation or coefficients of
change is sufficiently accurate, provided tha
the expected yield promises to be normal or
large and that the content of nitrogen and pho
phorus in the leaves is close to the "critical
level" of nutrition.

*Correlation between the content of nitroge
and phosphorus in the leaves, and the yields
indicators of adequate plant nutrients.* The
record of how wheat plants respond to chang
in the dosages of nitrogen and phosphorous
fertilizers, as well as the chemical analysis
of these elements in their leaves, have esta
lished a high positive factor of correlation b
tween the content of nitrogen in the leaves a
the grain yield (Fig. 3). The coefficients of
this correlation are given in Table 5.

Table 3

Effects of nitrogen deficiency in the soil on yield, and nitrogen content in the leaves and grain of wheat

Experimental variant and variety of wheat	Leaf nitrogen (in%) the stages:		P_2O_5 in during the flowering stage	Grain nitrogen, %	Grain yield, in g per pot
	Tillering	Flowering			
Without fertilizers, Lyutestsens 62	2.74	2.15	0.49	2.90	3.24
Without fertilizers, Gordeiforme 10	2.60	1.44	0.45	2.53	4.09

Table 4

Nitrogen and phosphorus content in the leaves of Mil'turum 553. Sovkhoz "Elita," 1957

Crop-rotatation field No.	Leaf content at the end of flowering, %			Ratio grain N	Grain content, %	
	Nitrogen	P_2O_5	Ratio N: P_2O_5	Leaf N	Nitrogen	P_2O_5
5	3.37	0.379	8.9	0.73	2.45	0.39
3	3.23	0.310	10.4	0.74	2.40	0.33
3	2.92	0.297	10.0	0.79	2.31	0.43

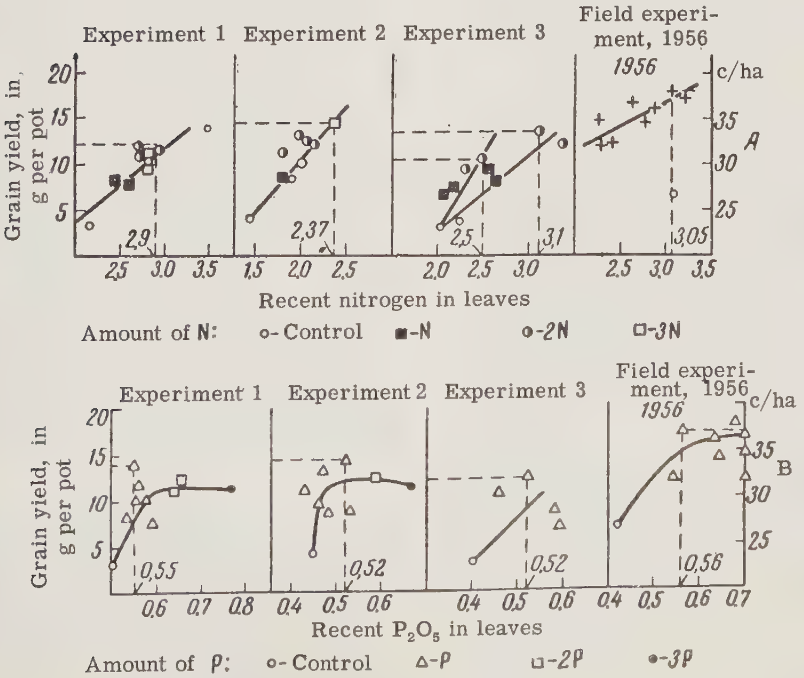

Fig. 3. - Relation between yield of spring wheat and nitrogen (A) and P_2O_5 (B) content in the leaves during the flowering period.

Table 5

Correlation coefficients between percentage nitrogen in the leaves at the end of the flowering period and grain yield in the 1955-1957 experiments

Experiment No. and variety of wheat	Year of experiment	Number of experimental variants	Soil moisture in % of full moisture capacity	Correlation coefficient (r)
1. Lyutestsens 62	1955	13	80	0.87±0.04
2. Gordeiforme 10	"	12	80	0.85±0.05
3. Lyutestsens 62 and Gordeiforme 10	1957	10(B)	60	0.94±0.03
4. Same	"	10(*A*)	80	0.93±0.03
5. Gordeiforme 10	1956	5	60	0.85±0.08
6. Same	"	5	60	0.73±0.14
7. Mil'turum 553, fixed experiment	"	8	—	0.80±0.08

The soil, used for Experiments 1-5, was taken from the same continuous-old plowed field. It contained sufficient amounts of available phosphorus and potassium (Table 6) (2).

When the plants are provided with enough phosphorus and potassium (Table 6), an application of nitrogen fertilizers leads to an increase of nitrogen content in the leaves. Until this increase reaches 3.0%-3.1% of the total chemical composition of the leaves, it is contributing to a very substantial increase to yields. Further increases of nitrogen in the leaves produce only diminishing returns. Thus, the optimum concentration of nitrogen in the leaves has been found. It corresponds to the concept of "critical level" of nutrients and assures large yields of wheat, provided that other conditions of cultivating wheat are favorable.

The term "critical nutrient level" means that the concentration of a nutrient in the leaves has reached a point, after which additional applications of fertilizers produce no positive results or even lead to a sharp decrease in yield (18, 19, 31, 36). To Magnitskiy (14) this term means the minimum concentration of nutrients in plants which can assure large yields. Let us consider from this viewpoint our own pot and field experiments.

During Experiment 1 (Fig. 3) each 0.1% increase of nitrogen content in the leaves within the limits of 2.15%-2.71% produced a 1.61 g increase of grain per pot. Further 0.1% increases of nitrogen resulted in only 0.26 g increase of grain. During the experiment with Lyutestsens 62 (4, p. 172, Table 2) each 0.1% increase of nitrogen content within the limits of 2.30%-2.93% produced a 1.67 g increase of grain; and after that only a 0.54 g increase, per pot.

During the experiment with Gordeiforme 10 (4, p. 172, Table 3) the largest yields were ob tained on soils of varying fertility when the co tent of nitrogen in the leaves measured betwee 2.72% and 2.86%.

During Experiment 3(B) (Fig. 3), the large yield corresponded to a 3.1% content of nitroge No critical nitrogen level was achieved during Experiments 2 and 3 (A) conducted under the conditions of increased soil moisture.

During the field experiment (Figs. 2 and 3) large yields of high quality grain were obtaine by providing 2.60%-3.05% content of nitrogen i the leaves of plants growing on fertilized plots The plants on the plots, kept for comparison, also contained in their leaves the "critical lev of nitrogen, but they were deficient in P_2O_5. application of superphosphate in combination with manure and NK was very effective in eliminating this deficiency of phosphorus (Tab 6) under the conditions of very good moisture during the growing season. Productivity of th plants was increased and the yield of grain wa improved, both quantitatively and qualitatively

This indicates that the "critical level" of th nitrogen should be combined with adequate sup of phosphorus, as well as, probably, of potassium (19, 24, 25, 34).

As in the case of nitrogen, the relation between the P_2O_5 content in the leaves and the grain yields is expressed by an almost straig line until the concentration of phosphorous aci reaches 0.52%-0.60% (Fig. 3). Further increases of P_2O_5 in the leaves have little effec on the yield, as has been already established other investigations (34, 36).

Our four years of experiments in the field

Table 6

Control of available nutrients in the soil of experimental plots before sowing, layer from 0-30 cm.

Experiment No. and year	Experimental plot	Preceding crop	Content in mg per kg of absolutely dry soil			Location of experiment
			NO_3	P_2O_5	K_2O	
1—2. 1955	Old plowland	Potatoes	12.5	136.4	101.4	Agricultural Institute
3—4. 1957	Same	Wheat	13.5	143.7	106.0	Same
5. 1956	"	Same	14.4	177.3	122.0	"
6 "	Twice-cultivated land	Maize	22.6	110	119.0	"
7 "	Old plowland	Oats	8.1	115.1	123.8	"
8. 1957	Third year following perennial herbs	Maize	27.5	117.7	211.0	Sovkhoz "Elita"

and laboratory, conducted under varying conditions in regard to the amounts of nutrients and degrees of soil moisture, have established several levels of nitrogen for wheat. Also, we have been able to chart the "critical level" of nitrogen and phosphorus. In doing so, we were concerned not only with the total yields, but also with the quality of wheat grain. Therefore, our "critical level" concept (37) takes into account the nitrogen content in the wheat grain.

To assure that the grain would not contain less nitrogen than is prescribed by the international standard (12.5%), a content of nitrogen in the wheat leaves during the flowering period should be maintained on about 2.60% level (Fig.). This corresponds to the lower limit of a number of "critical concepts," which assure large yields of high quality grain (30-35 c/ha), provided that there is enough moisture and that the supply of other nutrients is adequate (Fig. 2). The upper limit, according to our own experiments and the published data (5, 31, 36, 38), is 3.0%-3.1%. Concentration of nitrogen above this point exceeds nutrient requirements.

Our critical level for the phosphorous nutrition, required by spring wheat, is 0.52%-0.60% of P_2O_5. This is close to the critical level (0.53%-0.71% of P_2O_5) established by Lundegardth (34) for oats and wheat, and by Tyner (36) for corn.

Thus, the "critical level" of nitrogen and phosphrous for spring wheat calls for a content of 2.60%-3.0% of nitrogen and 0.52%-0.60% of P_2O_5 in the leaves during the flowering period. This level assures large yields (30-35 c/ha) of high-quality grain, provided that other conditions of cultivation are favorable. A calculation in advance of the nitrogen content in the grain is most accurate when the proportion of nitrogen to P_2O_5 is at 5.0 or fluctuates between 4.0 and 6.0. Table 7 contains data pertaining to other nitrogen levels and fertilization requirements for spring wheat.

Table 7 and Figure 2 show that it is still possible to obtain large grain yields when the leaves contain 2.3%-2.6% of nitrogen and a normal (0.52-0.60) percentage of P_2O_5. However, the grain would have a low content of nitrogen. That is to say, that the above outlined nutrient level causes a hidden nitrogen starvation, or the so-called "quality starvation." Therefore, when the leaves contain less than 2.60% of nitrogen and the yield promises to be average or large, it is necessary to conduct a nitrogen fertilization during the flowering phase in order to improve the quality of the wheat grain.

When the leaves contain 1.5%-2.3% of nitrogen, or a ratio of N to P_2O_5 is <3.5, and the yield is expected to be poor, there is a great need for nitrogen on the part of the plants. This often coincides with visual symptoms of nitrogen deficiency. Under such conditions, a nitrogen application during the flowering period is no longer effective. What should be done is to provide nitrogen from the very beginning of plants' life by applying starter fertilizers before the seeding. The same conclusion has been made in other studies (34).

A higher than 3.3% content of nitrogen in the leaves, or a ratio of $N:P_2O_5 >8.0$, is characteristic of an excessive consumption of nitrogen by the plants. It is most frequently observed during dry years when yields are small and the grain contains high percentage of nitrogen and protein (2). An excessive (non-productive) consumption of nitrogen has been observed during normally wet years and under very favorable conditions of nitrogen but with a considerable deficiency of phosphorus in the soil (Tables 4 and 8).

Thus, the spring wheat does not need nitro-

Table 7

Levels of nitrogen nutrition for spring wheat as indicator of soil fertility in regard to nitrogen

% nitrogen in leaves during flowering	Ratio $\frac{N}{P_2O_5}$ in leaves	Prospects for harvest at time of flowering	Probable % nitrogen in grain	Level of nitrogen nutrition with good supply of moisture	Plant needs for nitrogen fertilizers	
					add. appl. dur. the fol. stage	main app. for the following year
1.5–2.0	$\frac{2.5-4.0}{1}$	Low	2.5 or more	Very low	None	Strong
2.0–2.3		Average	2.0–2.2	Low	Strong	Average
2.3–2.60	$\frac{4.1-5.0}{1}$	Above average or high	2.1–2.4	Below average	Average	Little
2.6–3.0		High	2.4–2.8	Average or "critical"	Little or none	None
3.0–3.3	$\frac{5.1-6.0}{1}$	Same	2.8–3.1	High	None	Same
more than 3.3		Same	—	Excessively high	Same	Same

Table 8

Effect of mineral fertilizers on yield, and content of nitrogen and P_2O_5 in the leaves of Lyutestsens 758 spring wheat

Experimental variant	Leaf content at the end of flowering stage, % of absolutely dry matter			Grain yield, in cntr/ha	± m
	Nitro.	P_2O_5	$N : P_2O_5$		
Control	3.83	0.40	9.6	21.2	±0.35
N_{30}	3.87	0.38	10.2	22.0	±0.53
P_{45}	3.72	0.45	8.3	23.7	±0.47
$N_{30}P_{45}$	3.93	0.44	8.9	23.4	±0.68
$N_{60}P_{45}$	3.97	0.42	9.5	24.0	±0.50

gen when its content in the leaves at the end of the flowering period is 2.6%-3.0%, or when the ratio is $N:P_2O_5>5.0$. It does not need phosphorus when its leaves contain, during the same period, 0.52%-0.60% of P_2O_5, or when the ratio is $N:P_2O_5>5.1$.

The effectiveness of the leaf analysis in determining nitrogen and phosphorous requirements was confirmed by our field experiments[2] conducted in the sovkhoz "Elita" in 1957, (Table 8). A chemical analysis of the leaves showed that the plants were well supplied with nitrogen (the year was average moisture) and very short o phosphorus. The yield results confirmed these findings.

The ratio between nitrogen and P_2O_5 i the leaves of Mil'turum 553, cultivated o an adjacent field, was even wider (Table This meant that the plants were strongly deficient in phosphorus and that it would be necessary to apply phosphorous fertilizers to the field during the following years. It should be noted that the physio logical composition of the wheat grain proved to be deficient in phosphorus because it contained only <0.46 of P_2O_5 (32). This wa one half of the P_2O_5 content of the wheat grai raised on the experimental fields of the Agricultural Institute.

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[2] V. Ankushev and L. Karchevskiy, students of the Agronomical Department, participated in the field and laboratory experiments in 1957.

Conclusions

1. A direct correlation between the content of nitrogen in the leaves and in the mature grain has been established and expressed in mathematical terms. On this basis a sufficiently accurate prognosis of the grain quality in regard to nitrogen can be made under normal nutritional conditions, and an appropriate nitrogen application can be provided at the end of the flowering period.

2. A "critical nutrient level" of nitrogen and phosphorus for spring wheat has been charted. The following nutrient levels of nitrogen have been established: very low, low, below normal, "critical," excessively high.

By using these concepts, it is possible to supplement the data of field experiments on the application of fertilizers to the soil under study. It is also possible to estimate the need for nitrogen and phosphorous fertilizers for the following year of farming.

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CHRONICLE

RESULTS OF INTER-REGIONAL SCIENTIFIC CONFERENCE OF SOIL SCIENTISTS OF CENTRAL CHERNOZEM BELT

P. G. ADERIKHIN

In realization of the resolution of the First Inter-regional Soil Scientists' conference in 1958, the Council of the Voronezh Department jointly with the Voronezh State University soil science faculty, from April 15-17, 1959 held a scientific conference devoted to "Soils of the Central Chernozem Belt (CCB) and Ways of Increasing Their Fertility." These questions were raised during the discussion:

1. Problems raised by the December Plenary Session of the Central Committee of the CPSU and its 21st Congress for solution by Soviet soil science and agricultural chemistry.

2. Familiarization with new soil methods for use in further work of soil scientists.

3. Ways of raising fertility of the CCB soils based on latest accomplishments of agricultural science and technology.

4. Exchange of experiments of the research and practical operations of the agricultural experimental stations, advanced and secondary agricultural training establishments, collective and state farms.

5. Development of theoretical soil science and adapting the work of soil scientists to the requirements of agricultural production.

6. Standardization of soil chart compilation in collective and state farms; soil site index.

Those who took active part in the proceedings included soil scientists, agricultural chemists, agronomists, physiologists and reclamation personnel of advanced and secondary special training schools, research institutes, agricultural experimental stations and fields, regional directorates of agriculture, and individual collective and state farms of the CCB of the Voronezh, Tambov, Lipets, Orlov, Kursk, Belgorod and Penzen regions. At the conference, 26 lectures devoted to various soil science problems were read. Among the general lectures were the following: Problems of Soil Scientists and Agricultural chemists of the CCB in Light of Resolutions of CPSU 21st Congress (P. G. Aderikhin); Soil Maps and Cartograms as Necessary Planning Base of Combined Agricultural Enterprises (V. A. Frantsesson); Problems and Principles of Keying the Soils (S. S. Sobolev); Agricultural technical Methods of Raising Fertility of CCB Soils (V. V. Kvasnikov); Agricultural chemical Methods of Raising Fertility of CCB Soils (M. Ye. Pronin); Meliorative Methods of Raising Fertility of the CCB Soils (M. S. Tsyganov; and Biological Methods of Raising Fertility of the CCB Soils (N. I. Yakushkina).

Of the remaining lectures, the following are of particular interest: Soils of CCB Floodlands and Their Agricultural Use (M. I. Nenarokov); Relation of Various Crops to Soil Properties of Orlov Region (V. N. Kochetov); Chief Ways of Raising Soil Fertility in Grain-Sugarbeet Crop Rotation (P. Z. Tur); and Use of Floodlands for Fruit Crops in CCB (Ye. G. Bisti). In the lectures, much factual material of great importance was presented to soil science and agronomy. All the lectures evoked enthusiasm on the part of the participants.

The conference demonstrated that in the territory of the CCB, there is much diverse scientific-research and production activity on problems of geography and fertility of soils. The conference also provided the opportunity for voicing the following shortcomings in the work of soil scientists: lack of the necessary coordination in the work in various establishments; the lag in theoretical researches in field of soil science and agricultural chemistry behind requirements of agricultural practice; the unsatisfactory conduct of work on the cycle of substances in agriculture and on dynamics of soil processes; the inadequate attention diverted to hydrophysical properties of soils; at the agricultural experimental stations, in most cases the field tests were unaccompanied by studies of biochemical processes and dynamics of soils' physical properties; study of erosional processes is quite insufficient; study of soils' biological properties is unsatisfactory; the lack of departments of soil science and agronomy in the zonal V. V. Dokuchayev scientific-research institute of the CCB and at regional agricultural experimental stations; and agronomists and machine operators are slack in using the achievements of agronomic soil science.

The conference adopted a number of important resolutions directed toward eliminating the inadequate noted, and toward developing Soviet soil science for the solution of the problems imposed on agriculture by the 21st Party Congress.

TRAINING OF EXPERT SOIL SCIENTISTS IN THE USSR FOR CHINESE PEOPLE'S REPUBLIC

M. A. BOBRITSKAYA, Wan Tsung-tsing (Practician), and Yao Syang-lyan (Post-graduate)

In relation to accomplishing a breakthrough in development of the socialist economy, agriculture in the Chinese Peoples' Republic attained unprecedented successes in 1958. Rich harvests resulted from a thorough and proper use of conditions which were named after eight hieroglyphs: "water, fertilizer, soil, seed, density, struggle, equipment and care" as indicated by the Communist Party of China and Comrade Mao Tse-tung. Soil is important among these factors.

In order to increase the harvest of agricultural products in China, the chief problems now confronting Chinese soil scientists were defined in November of 1958 at the All-Chinese Conference of Soil Scientists in Usi district. These problems are:

1. Generalization of experience, in developing highly productive soils, accumulated by Chinese peasants. 2. Study of use of various fertilizers, especially organic. 3. Conduct of soil studies, regionalization and site index of soils. 4. Study of soil reclamation. 5. Study of soil properties with object of developing various agricultural systems. 6. Use of new methods in investigating soils.

Expert soil science cadres are needed for solving these problems. To this end, in the spirit of fraternal socialist cooperation and of scientific exchange, more than 50 individuals (35 of whom are post-graduates) are increasing (in the USSR), their knowledge of soil science. Training is conducted mainly in Moscow (V. V. Dokuchayev Soil Institute, Moscow State University, Moscow "Order of Lenin" Agriculture Academy im. Timiryazev and others), Leningrad, Kiev and Kharkov.

The young Chinese scholars are training in the specialties: genesis and geography of soils; — 12 persons; chemistry of soils and agrochemistry — 11; biochemistry and microbiology of soils — 7; reclamation of saline soils — 6; soil physics — 5; mineralogy of soils — 3; and erosion — 3.

In the V. V. Dokuchayev Soil Institute, Academy of Sciences, USSR, 10 post-graduates and 2 probationers are in training. Their instructors are the outstanding soil scientists of the Soviet Union: Corresponding Member of USSR Academy of Sciences, V. A. Kovda, and Professors N. A. Kachinskiy, A. V. Sokolov, M. M. Kononova, A. A. Rode, N. I. Gorbunov, S. S. Sobolev and Yu. A. Liverovskiy.

Along with grasping the theoretical and practical bases of Dokuchayev soil science, the Chinese post-graduates are mastering new methods of studying soils: the use of isotopes, aerial photographic surveying, large-scale mapping, X-ray structural and thermal analyses, electron microscopy, study of soils' organic substances, etc. The Chinese graduates participate with their Soviet counterparts in expeditions and surveys in various soil zones of the Soviet Union.

Training in the Soviet Union will help the young Chinese soil scientists upon returning to their homeland to solve the major soil science problems and above all the problem of efficient use of the soil resources of China for advancing agriculture and also to transmit to the Chinese youth the knowledge and experience of Soviet soil scientists.

This will contribute much to the building of socialism in the Chinese People's Republic.

OPEN LETTER TO SOVIET SOIL SCIENTISTS

G. A. KNYAZEV and YU. A. VINOGRADOV

The oldest scientific repository of our country is the USSR Academy of Sciences Archives which has the world's largest collection of manuscripts written by those active in science and technology.

In the Archives there are about 450 personal holdings and about 1,000 collections of manuscripts of academicians, corresponding members, professors, Honored Scientists and technicians, and other outstanding scholars of our homeland.

Unfortunately, the manuscript legacies of soil scientists occupy a trivial space in the Archives. There are now only 7 personal collections of soil scientists (including those of 3 academicians). Among them are the papers of Academician K. K. Gedroyts, Professors V. V. Dokuchayev, S. S. Neustruyev, A. A. Yarilov and others.

In the past 5 years, not a single holding of a soil scientist has been accessioned by the Archives. The Academy archivists are still confronted by much work in the research and preservation of manuscript legacies. In the whole history of the Academy, 5 academician-soil scientists were chosen, but only for 3 of them have the manuscript materials been more or less fully preserved. The holdings of many deceased scientists have still not been investigated. For various reasons several of these holdings were never turned over to the Archives, and are irrevocably lost to science.

The donation of scientists' holdings to the Academy's Archives is a particularly voluntary matter. Unfortunately, relatives or other descendants do not always understand the importance to science of a manuscript legacy. It is only in the USSR Academy of Sciences Archives that the manuscript legacies of scientists can be fully preserved, can be given a scientific description and can be used for scientific purposes.

For preservation in the Archives, the manuscripts of scientific works and the pertinent working materials, documentary materials characterizing the biography and activity of the scientist, autobiographical manuscripts — memoirs, diaries, literary works, illustrative materials — photographs, sketches, drawings, etc., scientific and other notes, reviews, reviews of works of others, and often the actual transactions of other authors, sandwiched among the materials of the given scientists are accepted. The combination of all such materials comprise the scientist's private papers.

With respect to materials accepted for storage from legatees, the Archives strictly follows all stipulations which are sometimes given upon donation. For a period set by law, the successors are assured a royalty should the scientist's manuscripts be published.

The Archives also receives personal papers from the scientists themselves. Such material are received and processed according to all th archive rules. Their use for any purpose is authorized in writing by the scientist who has donated his personal papers ("holdings-former as the archives state).

No charge is levied for storage in the Archives. In their day, for storage in the Archives Academicians V. L. Komarov and S. A. Zhebelev, Corresponding Member V. N. Beneshivich and others donated their private papers. Academician Ye. N. Pavlovskiy, Corresponding Member of USSR Academy of Sciences, P. V. Yernshtedt and other scientists donated portions of their personal holdings.

We appeal to all soil scientists of the Soviet Union, regardless of where they live, to parti pate in preserving the manuscript legacies of outstanding workers in Soviet soil science, by sending these materials to the USSR Academy of Sciences Archives. We request that the Archives be informed of the location of simila personal archives or individual manuscripts, an also that the scientists avail themselves of the opportunity to transmit their private holdings the repository of the USSR Academy of Science

REVIEW

SOIL MICROFLORA OF THE EUROPEAN PART OF THE USSR. A.V. RYBALKINA AND YE. V. KONONENKO. 1957.

T. V. ARISTOVSKAYA

Until now no major attempt has been made to summarize, in the form of a monograph, all the available scientific data pertaining to special features of microflora of various soil groups. Ye. N. Mishustin's book, "Ekologo-geograficheskaya izmenchivost' pochvennykh bakteriy" (Ecological-geographic variability of soil bacteria), which considered on a geographical plane only certain species of soil micro-organism, was published more than ten years ago. Since then microbiologists have obtained new data permitting a broad zonal comparison of the characteristics of microflora of different soil groups.

The book under review, published by the USSR Academy of Sciences in 1957, does represent an up-to-date summary of our knowledge of microflora of the zonal soil groups.

The authors used the ecological approach in considering characteristics of microflora of various soil groups on the basis of an analysis of a great number of written scientific works, as well as the results of their won experiments. (The book refers to 292 bibliographical titles).

The book consists of the following two parts:

1) Microflora of tundra, podzolized and chernozem soils — written by Rybalkina; and 2) Active soil microflora — written by Rybalkina and Kononenko.

The first part opens with a review of soil microbiology emphasizing the importance of the ecological approach. According to the author, this approach is a vital prerequisite for making microbiology a useful branch of soil science and agronomy. Before discussing the results of her own experiments, the author gives a brief description of the soil cover and climatic conditions of the areas under study and also a review of the microflora of various soil groups. The objects of her own investigations were tundra gley-surface and humic-iron soils of the northeastern province, soils of the forest-tundra of the northwestern province, podzolized soils of the Leningrad region, sod-podzolized soils of the Moscow region, and the thick chernozem of the Kursk region. The number of soil profile observations varied from one area to another with the tundra soils of the northeastern province receiving most (19 profiles) and the Kursk chernozem least (2 profiles) attention.

While carrying out her soil microbiological investigations, Rybalkina first considered the quantity and variety of species of bacteria developed on meat-peptone-agar. She noted a unique pattern of bacteria distribution in some of the soil profiles of the podzolized soil zone, characterized by the presence of maximum biological activity in humic-illuvial horizons. In her opinion, the qualitative differences of bacteria found in different soils and soil layers must be explained in terms of the specific physicochemical properties of such soils and the nature of their vegetative cover. This expressed desire of the author to correlate microbiological data with soil-chemical factors definitely deserves to be praised.

After determining species of bacteria developed on MPA, the author proceeded to make a comparative study of the ecological-physicological properties of different cultures of the same species of certain spore-bearing saprophytes. As a result of the study of specimens of different geographic races of five species — derived from tundra, podzolized and chernozem soils — the author came to the conclusion that the northern strains of certain species have the ability to develop in a wider pH-range than the southern strains. As to their adaptability to the thermic conditions of one or another zone, the northern strains proved, in the majority of cases, to be only a little more flexible than the southern ones.

The author paid a great deal of attention to the study of soil actinomycetes. The chapter, dedicated to this subject, begins with a usual review of earlier works.

In the majority of northern soils that have been studied the actinomycetes are found only in small quantities. Their number, however, increased in the highly cultivated humic-iron podzolized soils of the northwestern province.

The author divides actinomycetes in accordance with their ecological and culture properties into three groups. The first group consists of species common to all soils; the second, of less common species rarely found in tundra soils; the third includes species which develop mostly in chernozem soils. These three groups differ from each other in their physiological properties. While the species that belong to the first two groups were able to take advantage of various sources of carbon and nitrogen, those of the third group proved to be more demanding in this respect and could develop only on some of the nitrogen sources used by the author. Strains from different soil zones proved to be different in their relation to nitrogen sources and to the pH.

Actinomycetes, representative of tundra soils, were generally characterized by the highest degree of adaptability to various food sources and temperatures and, thus, should be considered more flexible, as compared to strains from latitudes further to the south.

The following sections of the first part of the book are concerned with ecological features of certain other micro-organic groups of various geographic origin. In each case a review of earlier works precedes the author's own observations pertaining to the distribution of the group in the soils under study, to its subdivision into species, and to its relation to certain environmental factors.

Various strains of *Clostridium Pasteurianum* were subjected to the most thorough investigation. The strains derived from northern soils developed in Winogradski's culture medium only in the presence of a symbiont, or after humic acid or yeast autolysate has been added. Cultures from sod-podzolized soils and chernozem do not need such conditions. On the basis of this the author divided the strains under observation into two groups: auxoautotrophic and auxoheterotrophic. The former group is more biochemically active; the latter is more flexible. Some strains change humic acid (its optical density may change and sometimes decoloration of the environment may occur).

The cellulose-decomposing micro-organisms were given considerably less attention. The data obtained were limited primarily to the distribution of such micro-organisms in various soils. The author observed that in tundra soils decomposition of cellulose, occurring mostly under the influence of fungi and actinomycetes, proceeds at a sluggish rate. The same process is much more vigorous in sod-podzolized and chernozem soils with bacteria playing the leading part. Correlations among cellulose-decomposers change during the growing season.

On the basis of the foregone observations, the author came to the conclusion that surface-gley and humic-iron soils are distinguished from sod-podzolized and chernozem soils by the scarcity of certain micro-organism groups (spore-bearing ammonifiers, actinomycetes an aerobic cellulose-bacteria) and by the weak activity of nitrogen-fixers and cellulose bacteria.

Cytophaga of these soils can develop only under the conditions of symboisis and metabiosis involving other micro-organisms.

While taking into the account specific features of the microflora of the northern soils under study, the author made suggestions as to how their biological processes could be intensified. Thus, to intensify the development and activity of the cellulose bacteria, it would be necessary to increase the content of nitrogen by narrowing the ratio between C and N. The application of mineral forms of nitrogen should be accompanied by the application of a thoroughly decomposed organic agent containing a vitamin complex.

The first part of the monography contains new factual data contributing to the broadening of our knowledge of the microflora in various soil groups. The author should be commended for the fact that, unlike many other soil microbiological researchers, she did not limit herself to a description of the quantitative and qualitative composition of microflora, but unde took to analyze the ecological-physiological characteristics of individual micro-organisms, in particular those which have not been studied before. The author has obtained interesting results from her study of actinomycetes group and *Clostridium Pasteurianum*, the latter being a difficult subject for microbiological investigations.

It should also be noted that the author has es tablished the fact that northern races of certain bacteria possess a superior flexibility as compared to southern races.

The method of ecological-physiological investigations, chosen by the author, proved to be correct and leads to a better understanding of the processes occurring in soils.

The work, however, is not without certain defects and minor technical errors. The seasonal dynamics were not sufficiently emphasized in describing the microflora of certain soils and in some cases the dates of the taking of samples were not properly recorded. In these respects, the soils of the northwestern province received the least complete treatment.

The second part of the monograph (A. V. Rybalkina and Ye. V. Kononenko) is devoted to the active soil microflora.

As a starting point for their study, the authors assumed that soil microflora is divided into the potential and active subdivisions. The former encompasses the sum total of all soil micro-organisms, regardless of whether they are in an active or dormant state at a given moment. Thus, it also includes the spores of such micro-organisms for whose change to the active state the present environment does not provide favorable conditions. The active microflora, on the other hand, consists only of micro-organisms leading an active life under the presently existing concrete conditions.

The innoculation method of the culture medium can be used only for determining the potential microflora. To study the active microflora the authors employed a modified variation of Kholodni's method.

Their modification consisted in putting a thin agar-culture film on the glass slides before inserting them into soil. In studying the active microflora of various soil groups, they used for this purpose starch-ammonium agar. According to them, this provided a bare minimum of culture medium: enough to stimulate the beginning of the development of micro-organisms without having a selective effect.

Parallel to this method, the authors also used analyses of group compositions of micro-organisms from the same soils. The book describes different types of the growth of micro-organisms on the agarized slides and presents a large number of micro-photographs showing the structure of microcolonies and of nidus congregations of micro-organisms.

In studying the effects of temperature and soil moisture on microflora under natural conditions, pot experiments of various soils under laboratory conditions were first conducted. These experiments confirmed the existence of a major difference between active and potential microfloras. The composition of the active microflora changes along with the changing of conditions. A change in temperature and moisture causes not only a change of the intensity of the development of micro-organisms on the slides, but also a change in their composition and morphological state. All groups of micro-organisms present grow in a culture medium, regardless of the soil conditions. But the only micro-organisms that grow on glass slides inserted into soil are those which can develop under given conditions.

Mold fungi proved to be the least demanding in regard to moisture and heat. Actinomycetes require higher temperature, while depending little on the degree of moisture.

Spore-forming and non-spore-forming bacteria proved to have different requirements for heat and moisture.

The authors conducted their practical observations also under varying soil conditions. They investigated the sod-podzolized soils of Moscow region, the southern chernozems of Balashov region, and the soils of the solonchak complex in the Caspian Plain. Their investigations of microflora of the sod-podzolized soils were carried out in the following types of land: forest, fallow, grasses and spring wheat. Their observations showed that sod-podzolized soils have a high biological activity during the period of high moisture and sufficiently favorable temperatures. The book contains data on the distribution of various groups of the active microflora over the genetic profile and outlines the basic regularities of the seasonal dynamics of the active microflora. The group of non-spore-forming bacteria proved to be most constant in its composition and quantity, while the fungi and actinomycetes were found to be, in these respects, subject to the greatest fluctuations.

In studying microflora of chernozems, the authors observed forest and converted-steppe field. They found out that the southern chernozems are rich in the main groups of micro-organisms important for agriculture, and that they are distributed to a considerable depth of the plowed profile. The microbial combination, which were revealed by the method of glass slides inserted into soil, proved to be extremely dynamic and sensitive to the external conditions. Different groups of micro-organisms develop under different conditions. When there is not enough moisture, the micro-organisms practically discontinue their life activity. Since during most of the growth period the chernozems contain little moisture and are thoroughly warmed, the authors concluded that fungi and actinomycetes — less demanding in respect to soil moisture than bacteria — represent the most characteristic part of the active microflora of chernozems.

From among the soils of the Caspian Plain the authors studied solonetz and dark-colored soils. All soils of the solonchak complex proved to have the main group of micro-organisms important for agriculture. Just as in the case of chernozems, their active microflora proved to be very dynamic.

One of the basic conclusions of the authors was that various soil groups differ little from each other as far as their potential microflora are concerned, but have much more pronounced differences in their active microfloras. Therefore, in addition to the potential, the active microflora must be studied in order to gain the knowledge of the biological soil processes.

Such an approach should be regarded as absolutely correct, in principle. The data furnished by the authors convincingly prove that the method of group analysis can produce only relative results which do not permit the passing of a correct judgment concerning the extent of the microbiological soil processes, occurring at a given time, and concerning the participation in these processes of various micro-organism groups. Therefore, the method of studying the active microflora, when used in combination with other methods of investigating soil micro-organisms, can produce some very valuable additional data.

However, it should be noted that some of the ideas expressed by the authors sound too categorical. For instance, while the assertion that various soils differ from each other in their active microfloras more than in the potential sounds plausible, the assertion that their differences in the potential microflora are only minor ones — is in contradiction to the accumulated earlier material concerning this problem. It is a generally known fact that, while all soils contain micro-organisms participating in varying degrees of intensity in all phases of the natural cycle, the species-composition of the same physiological groups of micro-organisms is different in different soils. And, of course, there are also physiological differences between various geographic races of the same species. Therefore, the previously mentioned assertion of the authors should be qualified. It is also difficult to believe that the starch-ammonium agar, which the authors used for their agarized glass slides, acts only as a stimulant for the beginning of the development of the active microflora, but does not have a selective effect. Actually, no matter how small the amount of the applied culture medium may be, it would still stimulate the development of only such micro-organisms whose requirements it meets. Thus, the first to develop on the glass slides would be such micro-organisms which utilize starch and the products of its decomposition. Unfortunately, the authors did not provide comparative data on the simultaneous use of the agarized water of starch-ammonium agar and of other agarized agents. The book does not make clear how much of such material was used by the authors.

The book also contains certain defects of stylistic and technical nature. However, all of this does not diminish the over-all positive value of the monograph. The authors collected and critically reviewed a large amount of literature, and conducted extensive observations under natural and laboratory conditions. As a result, they were able to arrive at new original data.

The authors should also be commended for their effort to find new methodical approaches to the problem of studying soil micro-organisms. The method, which they suggested, vividly shows the relative nature and limitations of the generally used methods of studying soil microflora. This method makes it possible to correct substantially the investigation results obtained by other methods.

The book contains a large number (178) of illustrations: diagrams, tables and photographs. The most interesting among them are the micro-photographs showing the types of the growth of micro-organisms on the glass slides. The monograph definitely represents an interest not only for microbiologists, but also for soil scientists working in the field of soil biology.

ISTORY OF USSR AGRONOMICAL CHEMISTRY

. L. BALASHEV, 1958.

Interest in agronomical history in the USSR
as increased greatly in recent years. Many
orks have been published, both those of a
irvey nature and those devoted to our out-
tanding agronomists. This is quite proper,
nce any scientific precept can be correctly
nderstood and evaluated only if its histori-
il development is manifested. This is es-
ecially valid regarding a number of agricul-
iral concepts relating to diversity of physico-
emical and biological disciplines in develop-
ent of agronomy, and in connection with the
omplexity and diversity of conditions of agri-
iltural practice. In this field, "new" often
roves to be the "well-forgotten old" and
ie can adduce many instances of the repeated
eatment of old problems without considering
ast experience, failure to use what has al-
eady been achieved, and the unbased estab-
shment of priorities.

We still do not have a history of the agro-
omical concept in the USSR. This makes
e attempts to clarify individual aspects and
roblems of agronomy even more valuable.
ne of such attempts is the new work by A. V.
okolov: "Historical Outlines of Agronomical
istory in the USSR." As the author writes,
is is not a history but only materials for a
ture history of agrochemistry, mostly refer-
ng to the Thirties. The book consists of sep-
rate outlines and therefore the author cannot
e censured for not having traced a general line
development of agrochemistry in our country
egarding the successes of chemistry and
ology. The abundance of facts and ideas in
e book, the scope of its theme and simplicity
presentation will doubtless attract many
eaders to the "Outlines."

In the first chapter, against a background
a general outline of the first efforts of
issian agronomy, views on fertilization in
issia up to the Sixties of the 19th century
e presented — the works of Bolotov, Komov,
oshman and Pavlov. Characterizing the views
Teer (Thayer), the author shows that the originator of the humus theory of feeding plants was not Thayer but Sossyur (Sossure).

The second chapter is devoted to the 1860-1890, to the works of Mendeleyev, Engelhart, Zaykevich and Kostychev. The author presents many important facts and interesting concepts, especially on the role of Liebig and Bussengot (Boussingault) in the development of agricultural chemistry views and on the theory (then accepted in Russia) of regression.

The author fails to mention Stebut in this chapter; he left a very great literary legacy in the field of agricultural chemistry. His dissertation "Liming of Soil," (1865) (not even mentioned in the list of literature) was the first and only in the past century and was a major contribution on this problem. We list his chief works on fertilization: "Treating Soil with Gypsum" (1868); "Exhaustion and Fertilization of Fields" (1869), where he argued against the complete return to the soil of nutrients removed by harvesting and, as did Lyudogovskiy, wrote about the fertilization of chernozem (which contradicts the statement of A. V. Sokolov that Zaykevich was the first to raise this question); editor of the translation (with his remarks) of Heyden's book "Science of Fertilization" (1869-1870); "How Lime and Nitrogen Fertilizers Work" (1871); the agricultural section in "Handbook for Russian Farm Managers" (1875), where Stebut presented an entire course on fertilization in about 150 pages, being a transition between the "Agricultural Chemistry" of Pavlov and the "Science of Fertilization" of Pryanishnikov. Stebut also presented extensive material on fertilizers in "Basic Field Cropping." He wrote much on the significance of "fertilization of seeds" (for instance, the article "Concerning General and Drill Sowing" (1870), where he stressed the importance of local fertilizing and wrote about combination drills. "For carrying out local fertilizing during drill sowing, for instance with the Sims drill, it is very convenient to set up special compartments for holding fertilizer, special blades for agitating it, and tubes for guiding the fertilizer into the same furrows in which the seeds are lying" (Selected Works, Vol. II, 291). A. V. Sokolov's remark on the exclusive role of Zaykevich on this question (pp. 48-49) seems rather exaggerated in the light of this.

In this same chapter, we noted two errors in dates. Engelhart moved to the Peterbury Agricultural Institute not in 1866 but in 1864 and did not stay in the Peter and Paul Fortress a year and a half, but for two months.

In the third chapter there is described the development of soil science and microbiology, connected with agricultural chemical investigations of Dokuchayev, Sibirtsev, Kossovich, Vinogradskiy and Omelyanskiy.

The fourth chapter treats the development of the Russian school of agrochemistry (the works of Timiryazev, Pryanishnikov, Kossovich, Gedroyts and a number of their students). Here the author touches on the history of using the pot experiments in Russia, but one can hardly agree with his statement that in developing this method, the Russian investigators "always" were ahead of foreign researchers.

The fifth chapter is a general outline of the development of Russian experimental work: work of the network of the Kharkov Society of Agriculture, the Poltava Experimental Field, Ivanov Station, Network of All-Russian Society of Sugar Manufacturers (Frankfurt, Dushechkin and others), Engelhart Station, Zemstvo experimental fields, cooperative tests with fertilizers, and conferences on experimental work.

The sixth chapter is a continuation of the previous one. It describes the experimental work after the October Revolution and the work of agricultural chemical departments at experimental stations; soil dynamics under field conditions are also discussed. The author stresses the organization of experimental work in the 1920's and the work of Doyarenko in Moscow "Order of Lenin" Agriculture Academy im. Timiryazev; both Lebedyantsev's work at Shatilov Station and other work at Poles Station are discussed.

The seventh chapter has a somewhat different approach. In it the development of research on specific problems of agricultural chemistry are outlined, namely: on phosphorite, lime, manure, green manures and biological nitrogen. When there is discussion, in historical narrative, of a certain problem and ways of solving it, one should never be limited to a fixed time segment, but should extend the argument to its present state. We adduce two examples.

Describing the development of the phosphorite problem (works of the Engelhart and Shatilov stations, the Geographic Network of the Scientific Institute for Fertilizers, investigations of Kossovich, Chirikov, and Golubev), the author indicates the importance (in using phosphorite) not only of the soil properties (adsorption capacity, nonsaturation state of bases, concentration of calcium ions), but also of the plant properties (root secretions, absorption of calcium) and their interaction (focal state of action, contact of roots and soil solution). Yet the development by us of the conditions of phosphorite's action is not exhausted by this. One of the main questions (on the relative role of plants, micro-organisms and soil in the decomposition of phosphorite) is still unexplained. Regrettably the author did not mention V. V. Butkevich's work (1928-1955) or that of a number of others, conducted on this topic, especially since he does not hold any dogmatic views himself. Soil acidity is considered only a "basic soil factor of effectiveness of phosphate fertilizer" ("Agricultural chemistry of Phosphorus," 1950; our underlining — L. B.).

It is also important to mention this since an attempt was made recently to trace the development of our scientific concepts on the phosphorite question. This was the article by D. L. Askinazi.[1] Its author, clinging to the parochial views of the 1920's, proceeds from the position that "among the factors of phosphorite's positive effect, the chief ones are soil conditions (acidity of the soil, its buffer state)..." (our underscoring) and does not mention a number of reports, particularly those evaluated positively by A. V. Sokolov. Hence it is unfortunate that the author of the "Outlines" did not discuss phosphorite more fully.

Another example refers to amount of phosphorite applied. From Table 5, in which are adduced experimental results of the Geographic Network of the Science Institute for Fertilizer, on winter crops, one can conclude that a double amount of phosphorite (90 kg P_2O_5) in all soils is inferior to superphosphate (especially since the author does not discuss the relative residual effect of these two phosphates). As early as 1936 in a survey on "Phosphorite in Soils of USSR," we demonstrated that under known conditions, a double application of phosphorite is not inferior to superphosphate. Since then, considerable material on this matter has been accumulated in experiments of the All-Union Fertilizer and Soil Science Institute in tests on red earths, and small applications of phosphorite were ıluated more favorably.

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[1] Effectiveness of Phosphorites as fertilizer. Izv. AN SSSR, seriya biol., 1959, No. 1.

In respect to liming, Sokolov should have
ɛed the collection "Liming of Soils and Ap-
cation of Fertilizers" (Sci. Inst. for Fert.,
19), which gave impetus to important re-
ırch (mentioned in the book) on this ques-
n. We also note that the first summary of
perimental data on lime was made by N. G.
shechkin as early as 1929,[2] 9 years prior
the summary of N. P. Remezov and S. V.
cherba.

Chapter Eight lucidly describes the Geo-
ıphic experiments conducted from 1926-
30 by the Science Institute for Fertilizer
l indicates their importance in developing
emical use in agriculture. With respect to
ble 8 which shows increased yields of four
ops according to "former tests" and tests
the Science Institute for Fertilizer, one
ı note that in it there are shown crop in-
eases in tests with large applications of
tilizer (120 kg/ha) and the author com-
res them with results of previous tests
ose applications are more nearly the same
those now being applied. He should have
nted this out. The geographic test data
l not change very perceptibly the concept
the fertilizers' effectiveness which was
ıluated in the summary of the Science Institute for Fertilizer: "Effect of Nitrogen, Phosphorus and Potassium on Crop Yields by Regions of USSR" (1932). The decrease, in effectiveness of using manure for fertilizer from west to east in European Russia was established in 1930.[3] In this chapter, A. V. Kazakov should have been included in the list of prominent scientists at the Science Institute for Fertilizer.

Chapter Nine is also of interest; it discusses forms of mineral fertilizers and is valuable since the author is an authority in this field.

The tenth and last chapter treats questions of use of chemicals in the USSR agriculture before the Second World War and discusses the techniques of using fertilizers and microelements (boron and copper).

The book has an extensive bibliography.

On the whole, A. V. Sokolov's work should be recognized as a valuable contribution to Soviet agricultural chemistry. It would be desirable for him to continue his historical-agrochemical researches and expand the new edition of "Outlines."

Transactions of Scientific Institute for Fertilizers,
. 66, 1929.

[3] "Geography of Effect of Fertilizing with Manure." Fertilizer and yields (Udobreniye i urozhay), 1930, No. 11-12.

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